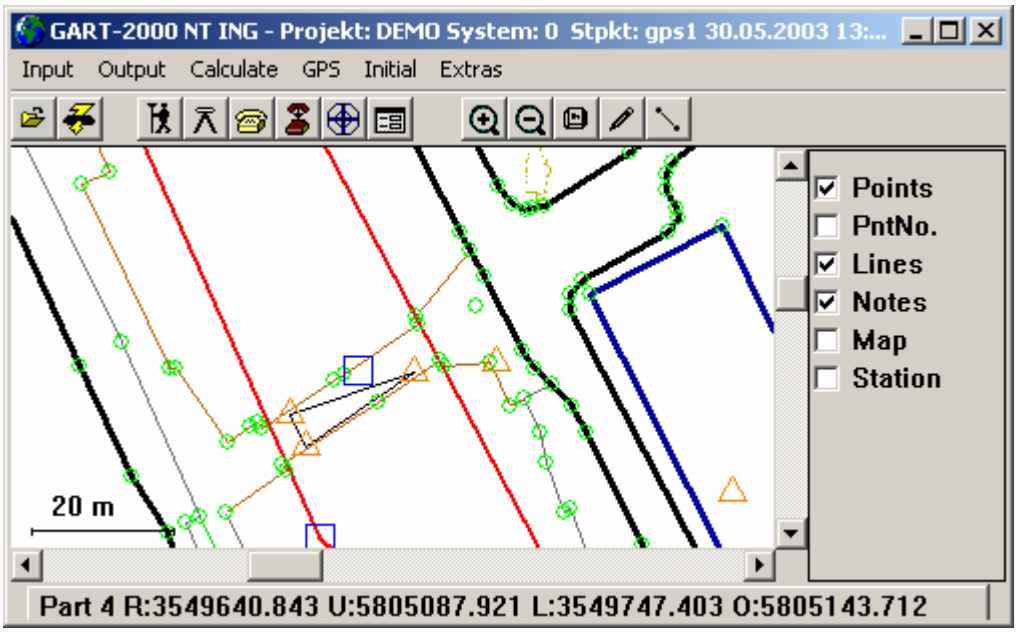
GART-2000®

- Reference Manual -



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1 Introduction

Congratulations on the purchase of the program system ***GART-2000® CE***. This reference manual was written to make the start with the software easier; moreover, it can be used as a reference book. In case of questions concerning the use of the software or the manual, please use the following address to ask for advice:

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ALLSAT-Email Service: software@allsat.de

GART-2000® CE was developed with the latest software techniques to guarantee the optimum hardware control functionality. The use of ***GART-2000® CE*** is easy so that a safe and intuitive work with the program and an efficient control of GPS receivers and total stations is possible. The software is used in the field of surveying, navigation and GIS-applications. The ***GART-2000®*** program system runs under Microsoft® Windows® 9x/CE/NT/2000/XP and Microsoft® DOS.

The screenshots used in this manual relate to a handheld PC with a screen resolution of 320x480 pixels. The layout of ***GART-2000® CE*** is adapted according to the kind of hardware deployed.

This reference manual was created with great care; even though mistakes can't be completely excluded. **Allsat GmbH network+services** is not liable for the consequences of wrong statements in this reference manual.

License terms

By the lawful purchase of the ***GART-2000® CE*** software and the manuals belonging to it the licensee is entitled to the use of these objects in compliance with the following specified license terms.

The licensee agrees to accept the license terms and to keep to them as soon as the software ***GART-2000® CE*** is executed.

§1 Object of the License

The **Allsat GmbH network+services** and **AB Software GmbH** claim all rights (licenser) to the software ***GART-2000® CE***. In accordance with these license terms the licenser gives the non-exclusive and the non-applicable right (license) to use this software and the documentation to the licensee.

The licenser has got the right to update or revise the layout and the contents of this software.

Products that are updated or revised are also subject to the provisions of this contract.

§2 Rights of Use, Misuse

The licensee accepts the licenser's rights to the product (patents, copyrights, trademarks, business secrets) unrestrictedly. That also includes the exclusive copyright on all analog and digital documentation. It is allowed to make copies of the product and documentation if this is necessary for backup purposes.

The right to use comprises the execution of the software with only one microcomputer.

It is not allowed to:

- use one license of the software with more than one microcomputer at the same time,
- change the functionality or the design of the software,
- pass the software or the documentation on to third (for example sale, letting, hiring out or free passing on)

Every not-licensed use is a violation of the licenser's patent rights and, therefore, can be prosecuted.

The licensee agrees to arrange all necessary steps to protect the licenser's rights and, especially, to prevent the unauthorized use, multiplication, passing on and publication of the software.

§3 Support

If training is part of the sales-contract, the licensee has got the right to the following support service offered by the licenser (this support service is limited to three months after the delivery):

Free updates of the software ***GART-2000® CE*** and all documentation

Hotline advice in case of problems with the use of the software.

Moreover, the licenser offers software-support contracts.

§4 Liability and Guarantee

The software is tested and - assuming appropriate use - checked. The licenser does not give a guarantee of the respective use of the licensee.

The licensee has to inform the licenser of bugs in the software immediately. Patches or the replacement of the faulty software is guaranteed.

The licensee will only have the right for restitution or reduction of the software price if the patches or the replacement fails within an adequate period of time (at least 4 weeks). The licenser does not give a guarantee of further indirect damages.

All claims to guarantee expire 12 months after the delivery.

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§5 Validity

The right of use comes into effect when the licensee pays the license fee to the licenser. The license is given for an indefinite duration.

If the right of use is not exercised any longer by the licensee or if it is revoked the licensee has got the duty to destroy all software and its documentation which he is in possession of or to send them - at his expense - back to the licenser. Moreover, the licensee has got the duty to preserve the licenser's patent rights even if he does not use the software any longer.

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Trademarks and company names of foreign companies are used without of the guarantee of free use. The licenser does not guarantee that described programs, circuitry, assembly, processes etc. are free from patent rights of third parties.

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All modifications or completions of these license terms are only effective if they are in written form.

Even if some provisions of these license terms are ineffective, the others still are effective. Ineffective provisions have to be replaced by others that correspond to the general purpose of the license terms.

The law of the Federal Republic of Germany is applied to this license agreement.

Any disputes arising hereunder will be settled before a court of law in Hannover, Germany.

Allsat GmbH network+services, Hannover, May 10, 2005

2 Installation

2.1 System Requirements

2.1.1 Hardware

The ***GART-2000® CE*** software package runs on a Handheld PC / Pocket PC with at least 32 MB main memory and minimum of 16 MB free permanent storage capacity. For the control of GPS receivers or total stations a serial RS232-port is needed. Furthermore we recommend using an internal Compact Flash-card (requirement when using a Pocket PC) to store the ***GART-2000® CE*** projects.

2.1.2 Software

The ***GART-2000® CE*** software is developed for use with the operating system Microsoft® Windows® CE 3.X/4.X.

2.2 Installation

The delivered ***GART-2000® CE*** program CD includes the **GART2000_CE.CAB** installation file. To install the software ***GART-2000® CE*** on your Handheld PC Pro, copy the file, e.g. with the Microsoft® ActiveSync software (included on CD), into a temporary directory on the Handheld PC Pro and in addition onto the Compact Flash-card.

Start the **GART2000_CE.CAB** file from the temporary directory with a double-click on the file name.

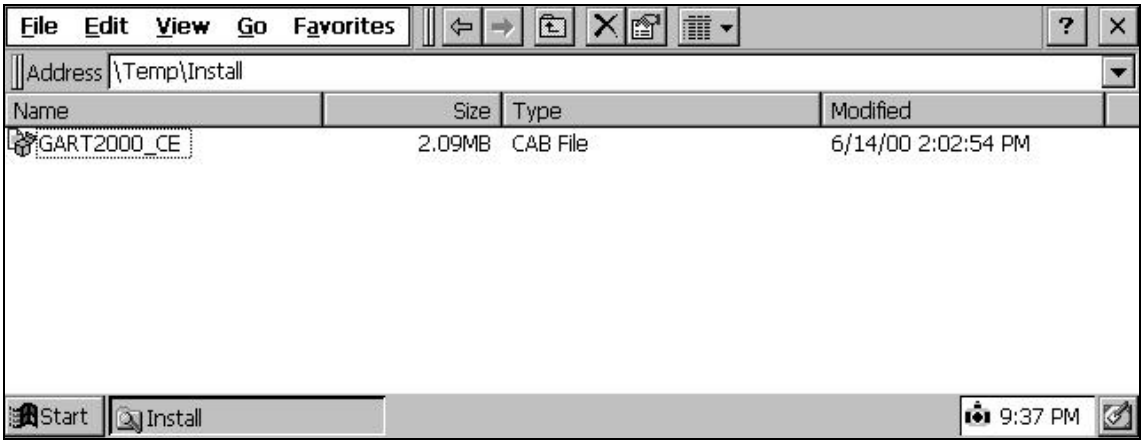


*Figure 2-1: Copy the installation file **GART2000_CE.CAB** into a temporary directory*

First the install program asks for the ***GART-2000® CE*** installation directory.

The default install directory is the Compact Flash-card. The reason for this is the fact that a hardware reset or a power failure will reset the Handheld PC Pro to its factory defaults. After this all files that are not stored on the Compact Flash-card will be lost!

*Figure 2-2: We recommend to install **GART-2000® CE** on the Compact Flash-card*

The installation program copies all necessary files into the chosen directory and creates a link with the ***GART-2000® CE*** icon on the Desktop.

The installation file **GART2000_CE.CAB** will be deleted afterwards.

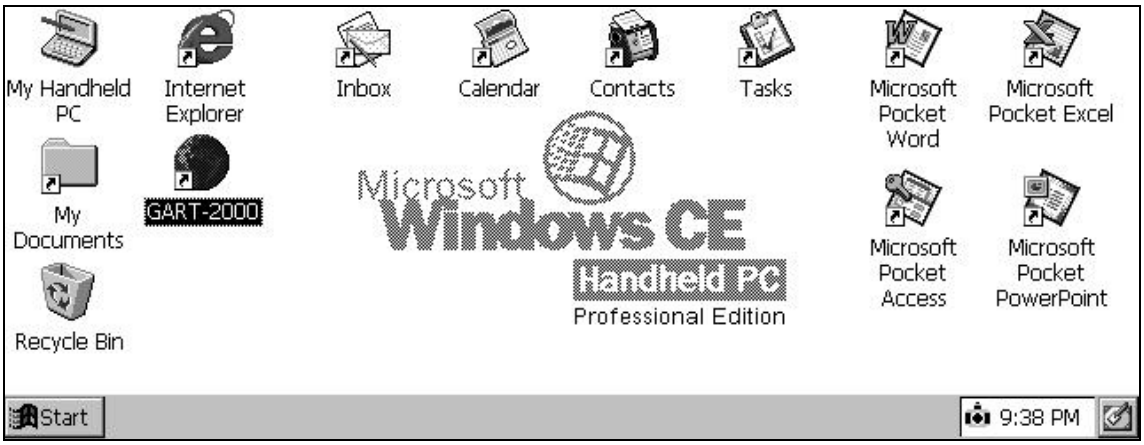


*Figure 2-3: **GART-2000® CE**-icon on the desktop*

To start ***GART-2000® CE*** simply double-click on the program icon.

3 Getting started with *GART-2000® CE*

The aim of this chapter is to enable the user to produce RTK coordinates with a minimum of 9 necessary steps in ***GART-2000® CE***:

3.1 Initialisation of GPS Constants
3.2 Input of Reference Coordinates
3.3 Initialisation of the Base Receiver
3.4 Initialisation of the Rover Receiver
3.5 Enter Station
3.6 Input of GPS Measurements
3.7 Receive differential Correction via cell phone (GSM)
3.8 Output of Measurements and Coordinates
3.9 Local Transformation

For more information see chapter ***Menu Control***.

The following figure shows an overview of the ***GART-2000® CE*** menu structure:

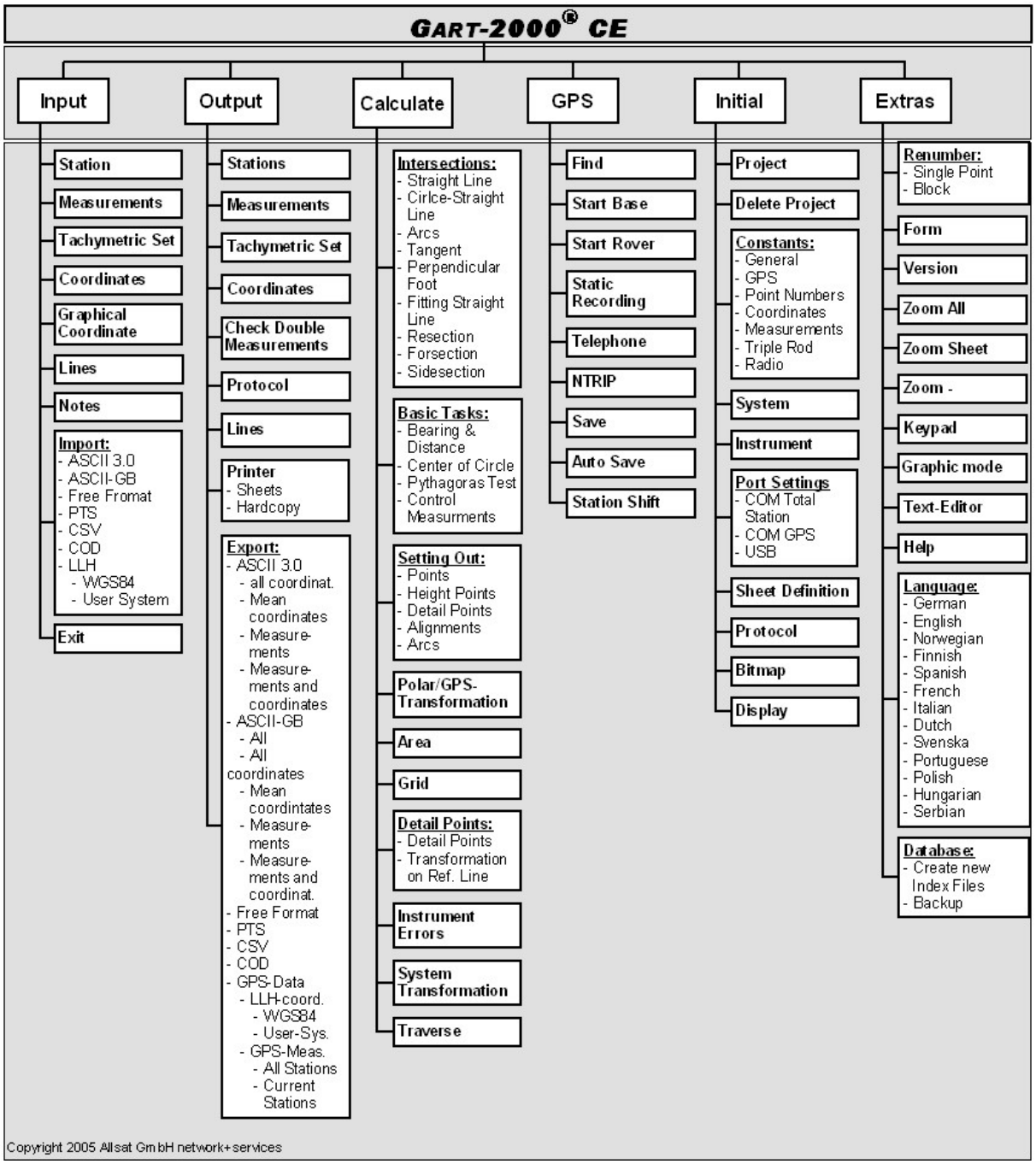


*Figure 3-1: The **GART-2000® CE** menu structure*

3.1 Initialisation of GPS Constants

The ***GART-2000® CE*** software initialises GPS receivers using the constants in the ***Initial > Constants > GPS*** menu.

Alternatively, use the button shown above to choose this menu.

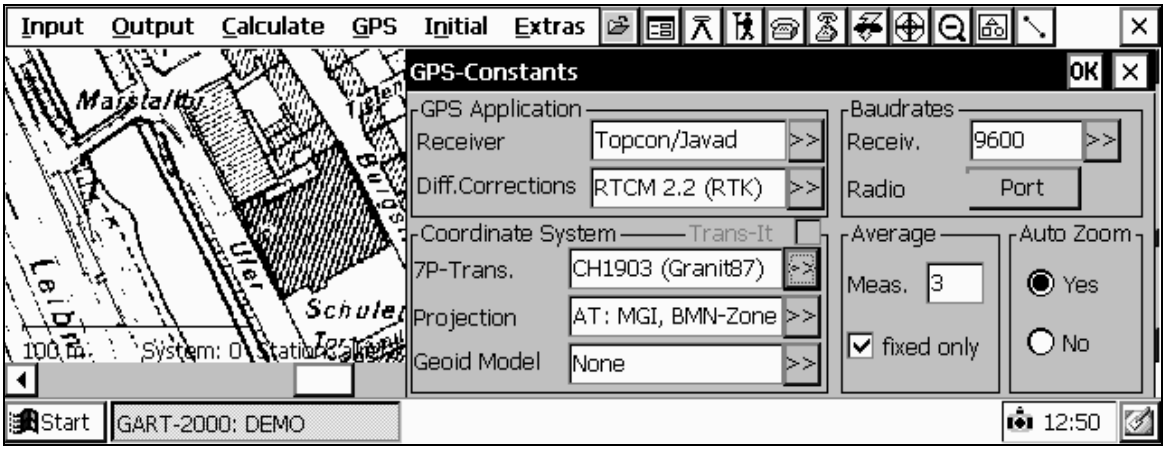


Figure 3-2: GPS-Constants

GART-2000® CE supports the following differential correction formats for GPS receivers:

Ashtech CPD (RTK)	Ashtech internal corrections for cm-accuracy
Ashtech RTCM (DGPS)	General corrections for m-accuracy
Ashtech RTCM 2.1 (RTK)	General corrections for cm-accuracy
Trimble CMR (RTK)	General corrections for Trimble 4000 series
Topcon RTCM (DGPS)	General corrections for m-accuracy
Topcon RTCM 2.1 (RTK)	General corrections for cm-accuracy
Topcon RTCM 2.2 (RTK)	General corrections for cm-accuracy
Topcon RTCM 2.3 (RTK)	General corrections for cm-accuracy
Topcon RTCM 3.0 (RTK)	General corrections for cm-accuracy
Topcon CMR (RTK)	General corrections for cm-accuracy
Topcon CMR+ (RTK)	General corrections for cm-accuracy
Topcon JPS (RTK)	Topcon internal corrections for cm-accuracy
Topcon OmniSTAR	For Topcon-receiver, which accept OmniSTAR correction data; m-accuracy
Sokkia RTCA	Sokkia internal corrections for cm-accuracy
Sokkia RTCM (DGPS)	General corrections for m-accuracy
Sokkia RTCM 2.2 (VRS)	General corrections for cm-accuracy
Sokkia CMR (RTK)	General corrections for cm-accuracy
Thales RTCM (DGPS)	General corrections for m-accuracy
Thales RTCM 2.2 (RTK)	General corrections for cm-accuracy

Thales LRK (Long Range) RTK	Thales internal corrections for cm-accuracy
Leica RTCM (DGPS)	General corrections for m-accuracy
Leica RTCM 2.1 (RTK)	General corrections for cm-accuracy
Leica RTCM 2.2 (RTK)	General corrections for cm-accuracy
Leica CMR (RTK)	General corrections for cm-accuracy
Leica CMR+ (RTK)	General corrections for cm-accuracy
Leica RTK	Leica internal corrections for cm-accuracy
NavCom Auto-Input	Can be chosen for a rover; the best correction is chosen based on a priority list (RTK, RTG, WCT,RTCM, WAAS)
NavCom NCT (RTK)	General corrections for cm-accuracy
NavCom RTCM (DGPS)	General corrections for m-accuracy
NavCom RTCM 2.2 (RTK)	General corrections for cm-accuracy
NavCom CMR (RTK)	General corrections for cm-accuracy
NavCom StarFire (RTG)	General corrections for m-accuracy
NavCom StarFire (WCT)	General corrections for m-accuracy
NavCom SBAS (WAAS/EGNODS)	General corrections for m-accuracy
Septentrio RTCM (DGPS)	General corrections for m-accuracy
Septentrio RTCM (RTK)	General corrections for cm-accuracy
Septentrio CMR (RTK)	General corrections for cm-accuracy
Septentrio SBAS (WAAS/EGNOS/ MSAS)	General corrections for m-accuracy
Standard NMEA	General format for use of other receiver types (e.g. for GIS-applications)

The transformation parameters can be selected from several preset entries (for instance DHDN, STN 42/83, WGS84,...) and various modifiable entries (e.g. User081).

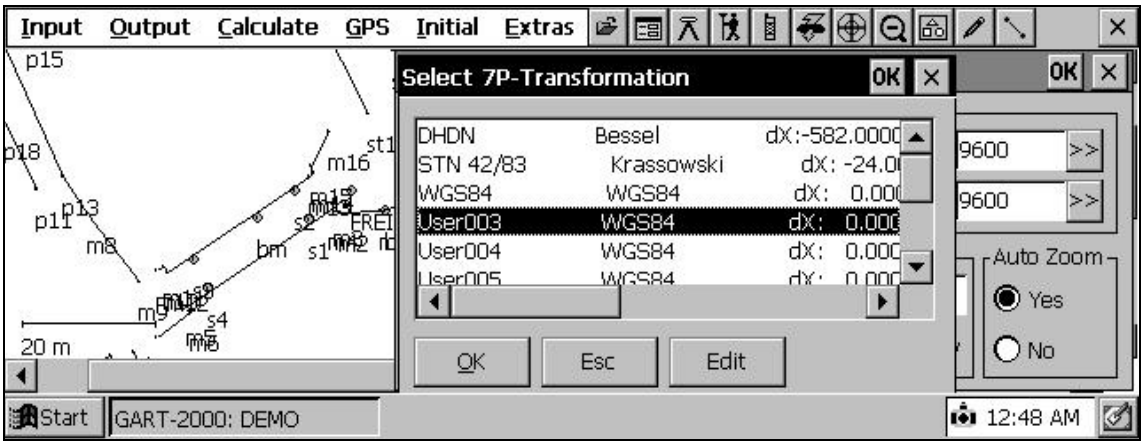


Figure 3-3: Select 7-Parameter-Transformation

After pressing the **<Edit>** button, the 7 transformation parameters for the modifiable entries can be edited.

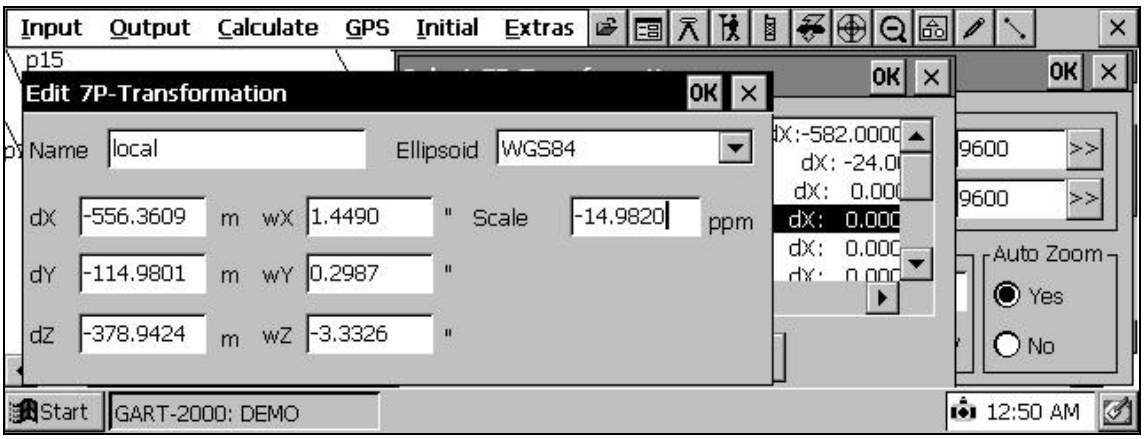


Figure 3-4: Edit 7-Parameter-Transformation

The entries have the following meanings

Name	Name of the set of transformation parameters (user-definable).
Ellipsoid	Ellipsoid of the user system.
dX, dY, dZ	Translations for X-, Y- and Z-axis.
WX, wY, wZ	Rotation with respect to X-, Y- and Z-axis.
Scale	Scale factor in ppm

If a transformation, accessible as identical points within the menu ***Calculate > Polar/GPS-Transformation***, was set to local 7-Parameter-Transformation (BursaWolf), pressing the button "Local 7P" will define an individual 7-parameter-record out of the transformation and will accept these parameters for the global GPS-constants.

3.2 Input of Reference Coordinates

The reference coordinates can be entered manually into ***GART-2000® CE*** or can be imported from a file. For the manual input of coordinates use the ***Input > Coordinates*** submenu.

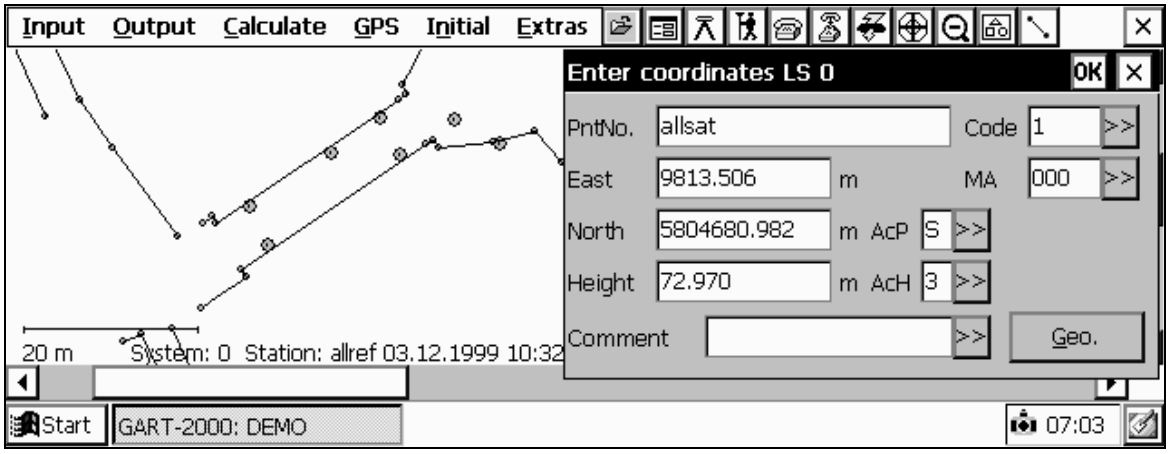


Figure 3-5: Input coordinates

The coordinates can be entered either in plane or, using the button **<Geo.>,** geographical (WGS84) mode. A conversion between user-coordinates and geographical mode is done automatically when switching between the modes. The current user coordinate system is used for the conversion; this system is set under ***Initial > Constants > GPS.***

Inputs can also be done by using a keypad. Under ***Extras > Keypad*** the keypad can optionally be activated or deactivated. If it was activated, the keypad appears directly after clicking into an input field.

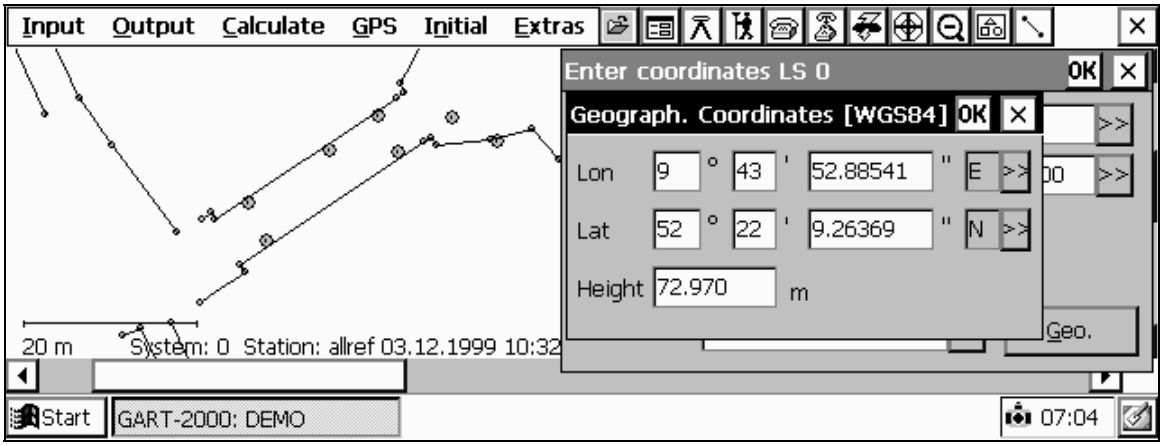


Figure 3-6: Input geographical WGS84 coordinates

3.3 Initialisation of the Base Receiver

The initialisation of the Base station is done with the ***GPS > Start Base*** submenu or the button shown above.

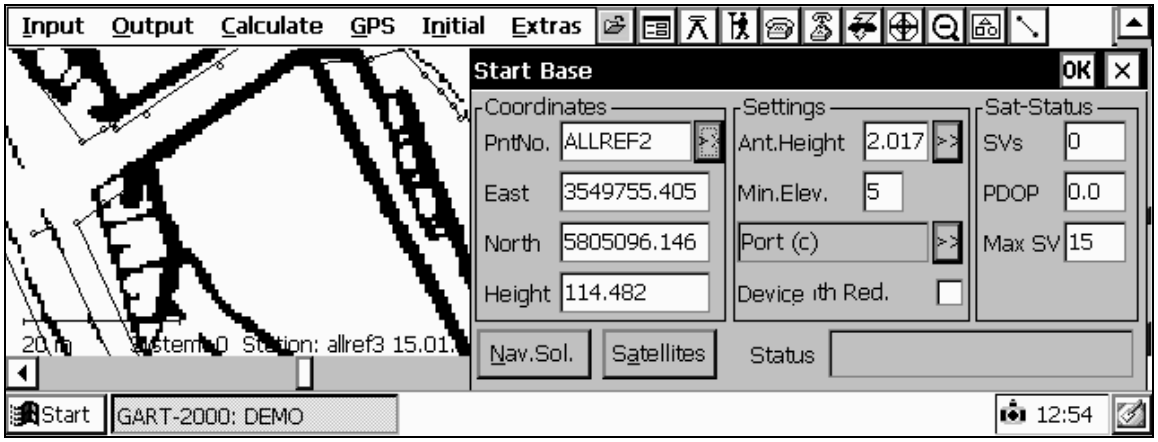


Figure 3-7: Initialisation of the Base Receiver (here: Topcon)

In this menu you can enter the name of the reference station, the plane coordinates of the reference point, the antenna height, the elevation mask and the radio-port.

Furthermore for Topcon-receivers the maximal number of used satellites can be chosen and the **Multipath-Reduction** can be activated. Therefore the Base- and the Rover-receiver need to have the necessary option. The multipath settings should be the same for base and rover receiver. To send out Base corrections over multiple radio ports the **<Port>** check box needs to be activated.

The button **<Nav.Sol.>** reads a position from the navigation solution of the receiver if the receiver tracks four or more satellites. The button **<Satellites>** shows the available satellites if ***GART-2000® CE*** is able to establish a connection to the GPS receiver. After having done all settings the button **<OK>** initialises the Base receiver and saves the reference coordinates.

The button **>>** next to the field **Ant.Height** opens the submenu for the Antenna Height. Choose the manufactory and the antenna type: Ashtech, NavCom, Sokkia, Thales, Topcon, Trimble and others. For each antenna type the individual antenna offsets are shown.

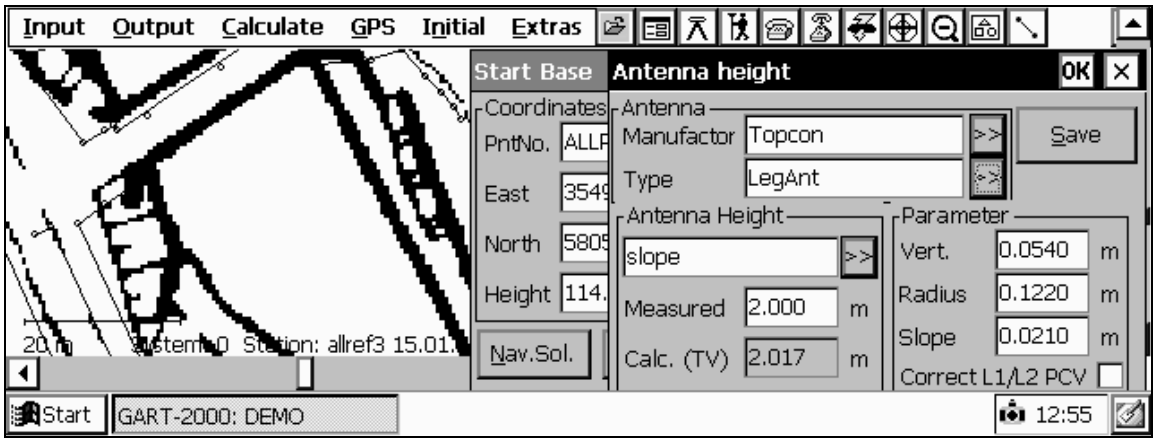


Figure 3-8: Antenna height

Enter the type of antenna height measurement:

"instrument height": measured from the marker to the bottom of the antenna at the base of the mounting threads,

"slope": measured from the marker to the lower edge of the groove around the antenna at the seam between the top and bottom halves of the antenna casing.

In the field ***Measured*** enter your slope or vertical antenna height. The true vertical height will be calculated immediately and will be shown in the field ***Calc (TV)***. After terminating this window with the **<OK>** button, the true vertical height will be set as antenna height in the measurement window. The button **<Save>** is only needed to store additional antenna types.

By activating the checkbox **<Correct L1/L2 PCV>,** the offsets between L1 and L2 of the antenna phase center (North, East, Height) are sent to the reference station for the respective antenna type.

The true vertical antenna height in ***GART-2000® CE*** accounts for different antenna offsets in case different antenna types are used on base and rover. In addition to the predefined antenna types in the list; you may enter your own antenna types. To do so enter a new name for your antenna and edit the values in the offset fields. The button **<Save>** stores the new entry.

If you have selected the correction data format ***"Standard NMEA"***, the function ***GPS > Start Base*** is deactivated.

3.4 Initialisation of the Rover Receiver

The initialisation of the Rover receiver is done with the ***GPS > Start Rover*** submenu or with the button shown above.

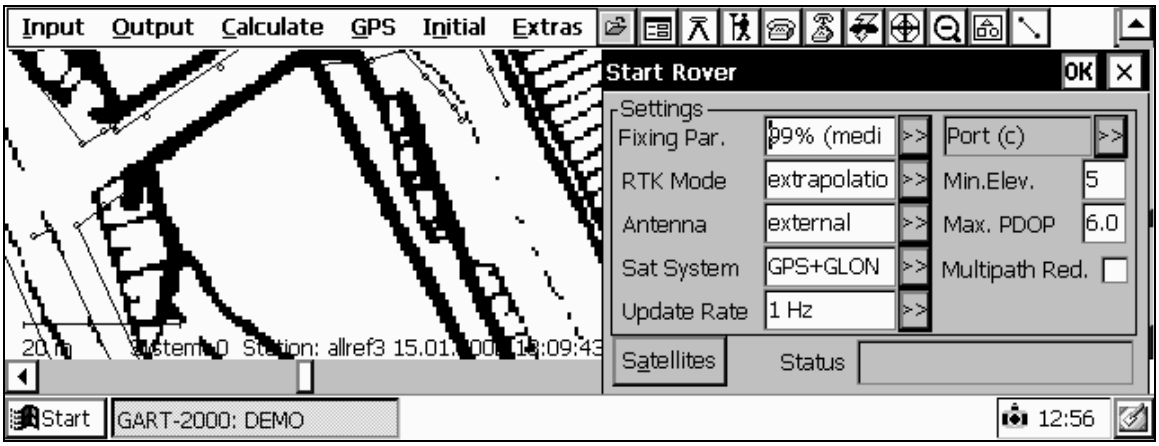


Figure 3-9: Initialisation of the Rover Receiver (here: Topcon)

Enter the input-port for the differential corrections (using radio or cell phone (GSM) modem), minimum elevation and maximum PDOP.

In addition for Topcon receivers enter the RTK mode (extrapolation or delay), antenna type (internal, external or automatic), the sat-system (GPS or GPS&GLONASS), the Update Rate (1 Hz and 2 Hz) and optionally activate the multipath reduction. The RTK-mode can be set to 'extrapolation' or 'delay'. 'Extrapolation' decreases the latency of the position and can extrapolate through short radio outages. 'Delay' is more accurate and is the normal mode for RTK surveying of fixed points.

For Topcon and Ashtech receivers a fixing parameter can be entered. The fixing parameter defines the confidence interval for the ambiguity fixing:

confidence interval	fixing parameter Ashtech	fixing parameter Topcon
no ambiguity fixing	float	float
90 %	very low	--
95 %	low	low
99 %	medium	medium (default)
99,9 %	high (default)	high
99,99 %	very high	--

A confidence interval of 99.9% means that statistically one out of thousand ambiguity fixings is wrong.

Use the **<OK>**-button to initialise the Rover receiver.

3.5 Enter Station

After a successful Base-initialisation a new station should be entered in the submenu ***Input > Station*** in ***GART-2000® CE***. A list of all stations is displayed.

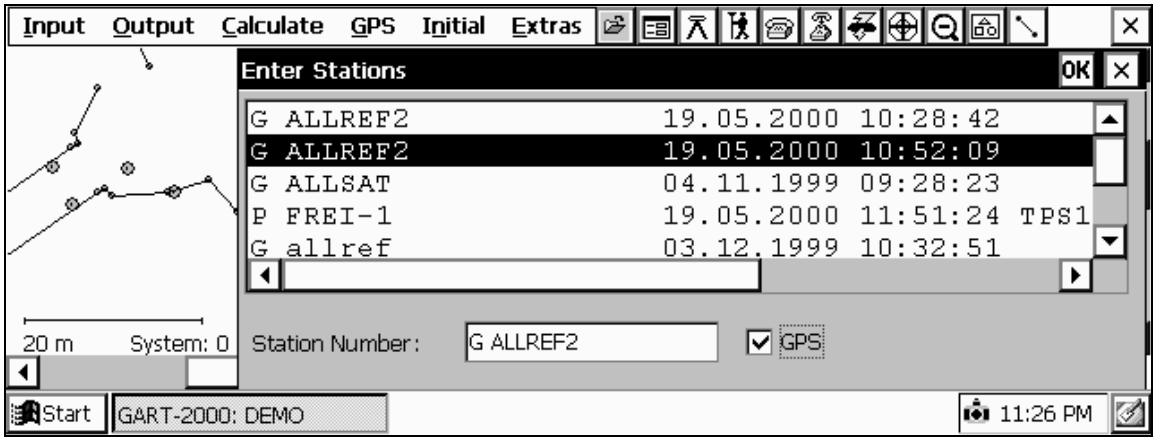


Figure 3-10: Enter Station

Enter a new name in the field **Station Number** or double-click to choose an existing station. We recommend to create a new station every time the Base receiver is setup on a new point.

To enter a new GPS station, activate the checkbox **<GPS>.**

If a new station is chosen, ***GART-2000® CE*** opens a dialog to query information about the station like instrument height, location, observer and the weather conditions. Press the button **<OK>** to save the data.

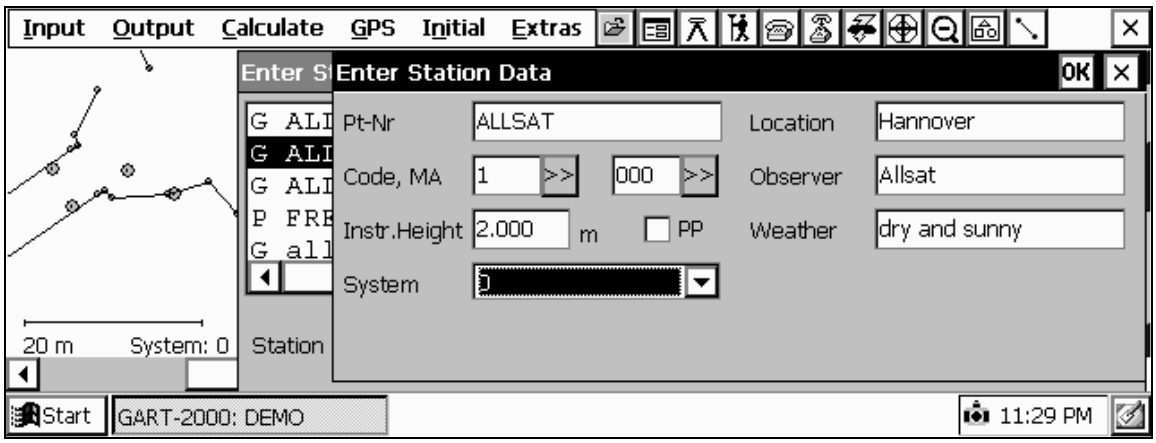


Figure 3-11: Enter Station Data

The current selected station is highlighted in the ***Output > Stations*** dialog.

3.6 Input of GPS Measurements

The ***Input > Measurements*** submenu includes the main screen for GPS surveying where the calculated coordinates and the status of the Rover receiver are shown. Alternatively, start the submenu with the quickstart button shown above.

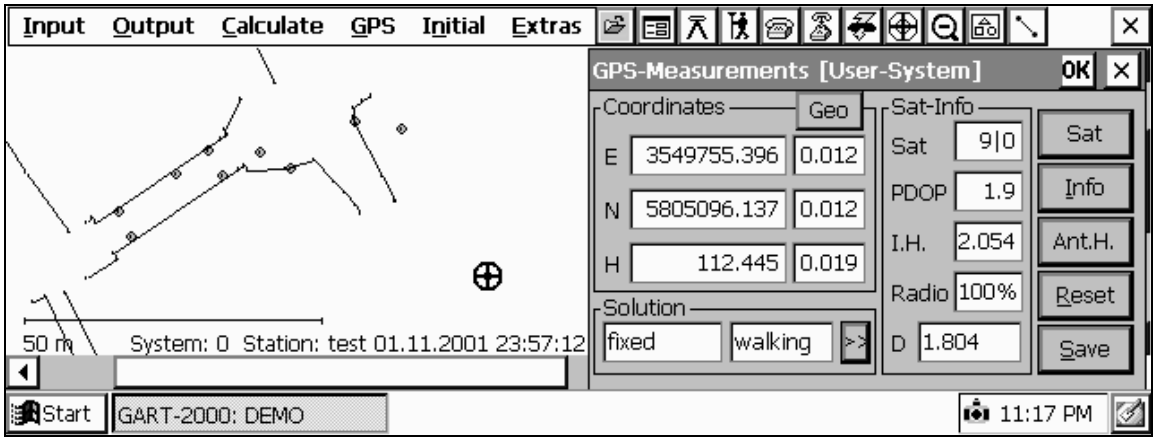


Figure 3-12: GPS-Measurements

The submenu shows the coordinates with their standard deviations (plane coordinates), number of GPS and GLONASS satellites, PDOP, antenna height **I.H.**, radio link quality, the distance to the Base receiver **D**, the ambiguity fixing status and the Rover dynamics.

The calculation of the ambiguities in the GPS receiver is influenced by the chosen dynamics. The dynamics describe the movement of the GPS antenna.

With the button **>>** the dynamics can be chosen from a list. Possible settings for Topcon are ***"static"*** and ***"walking"***. For Ashtech-receivers there are ***"quasistatic"***, ***"walking"***, ***"automobile" ,"aircraft"*** and ***"ship"*** additions.

The button **<Sat>** shows detailed information about GPS/GLONASS satellites.

When the **<Info>** button is pressed, a row of buttons appears for Ashtech and Topcon receivers that enables further information to be queried from the GPS receiver. (See Figure 3-13)

The **<Ant.H>** button opens the menu to enter the antenna height, which has already been explained in relation to the initialization of the reference station. Changing the antenna height has a direct effect on the representation of the coordinates.

With the **<Reset>**-key a reset of the RTK engine is done. The fixing of the ambiguities is restarted.

To save the actual coordinates press the **<Save>**- or the **<OK>**-button.

The **<Geo>** button converts the measurement values into geographical coordinates.

By means of the **<Exc>** button points can be measured with the aid of a connected tachymeter or MDL that are not directly accessible with the rover.

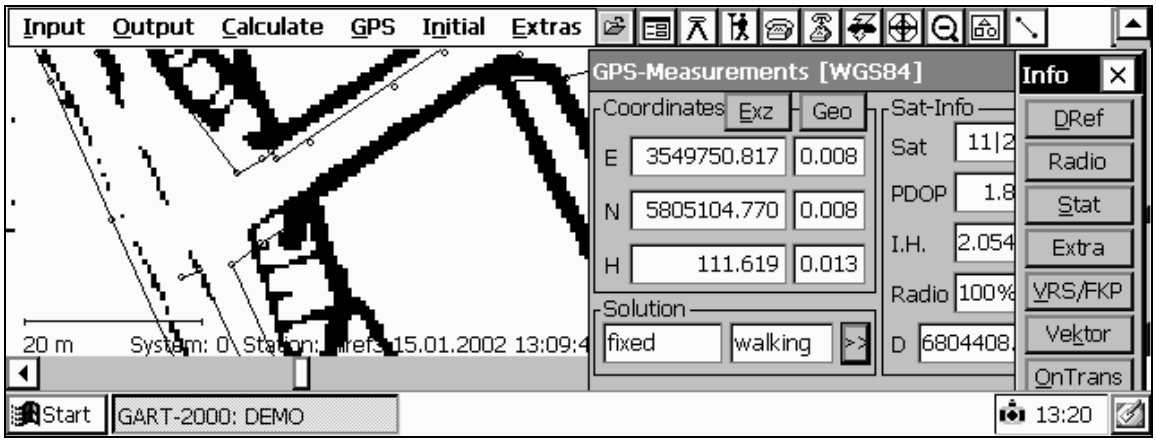


Figure 3-13: Info (for Topcon-receiver)

Supported functions:

<DRef>	This function reads the coordinates of the Base receiver from the RTCM messages and saves it. These coordinates are used to calculate the distance from the Rover to the Base receiver. If vector data recording has been set, the distance display is updated automatically.
<Radio>	The status of the received correction data is displayed.
<Stat>	Statistic for the position calculation (Topcon only)
<Extra>	Possibility to change the elevation mask and the environment type (forest or **open plain**) (Topcon only) In the field **Elevation** a degree figure can be entered to specify the minimum elevation of the satellites used to calculate position. The checkbox **<Co-Op Tracking>** enables the control of Co-Op tracking. **Ext. Power** displays the present input voltage of the receiver. **Power A** and **Power B** indicate the voltage of the internal rechargeable batteries A and B (only relevant to Hiper and Odyssey-E from Topcon). **Power Board** provides information on the voltage that exists on the board.
<VRS/FKP >	Settings for virtual base station or area correction parameter. (Topcon only)
<Vektor>	Absolute coordinates of base and rover in cartesian coordinates. If the checkbox **<Vectordata Recording>** is activated the correlations of the coordinates will be saved. (Topcon only)
<OnTrans>	Status display for the online transformation
<Power>	Indication of the battery capacity. The voltage and the capacity as well as the maximum and remaining battery time are shown. (Ashtech Z-Surveyor only)
<Contrast>	Indication of the Contrast Ratio Value. The contrast value declares how reliable the fixing of the ambiguities is. Ashtech: Range from 0.00 up to 999.0. A value higher than 1.0 indicates that the ambiguities are fixed. (Ashtech only)

3.7 Receive differential corrections via GSM

To initialise the cell phone (GSM) choose the ***GPS > Telephone*** submenu or press the quickdial button shown above.

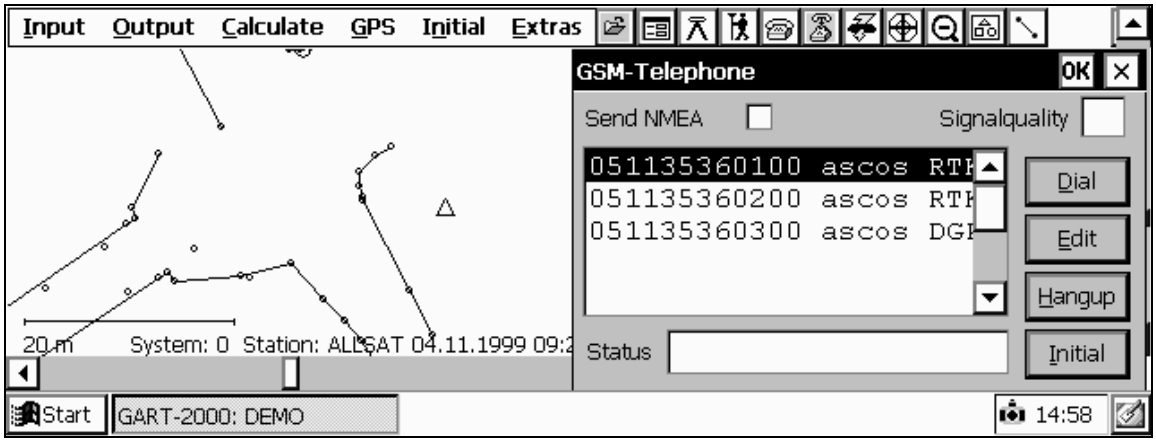


Figure 3-14: Telephone directory

Choose an existing number out of the list or enter a new one by pressing the button **<Edit>** in an empty row. Up to 20 numbers can be saved.

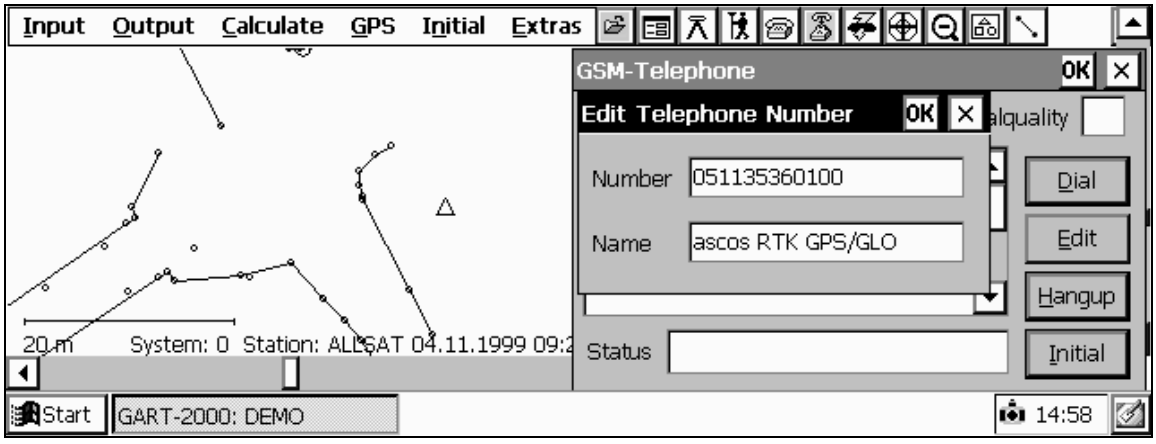


Figure 3-15: Edit Telephone Number

By pressing the button **<Initial>** configure the telephone initialisation strings (PIN, etc.). The field **Signalquality** shows the quality of the GSM network.

Mark the checkbox **<Send NMEA>** if you use a reference network service. When using your own local reference station leave this checkbox unchecked.

After selecting the appropriate telephone number, press the **<Dial>** button to establish the GSM link to the reference station. The number chosen should appear in the display. As soon as the status window ***"Connected"*** is displayed, quit the telephone menu with **<OK>**.

To stop the telephone connection, press the quickhangup button or the button **<Hangup>.**

The quickdial button dials the last selected telephone number and closes the window ***cell phone (GSM)-Telephone*** automatically if a connection is build up.

3.8 Output of Measurements and Coordinates

The stations, measurements and coordinates saved in ***GART-2000® CE*** can be edited/viewed with the menu ***Output***.

The coordinate output is shown underneath:

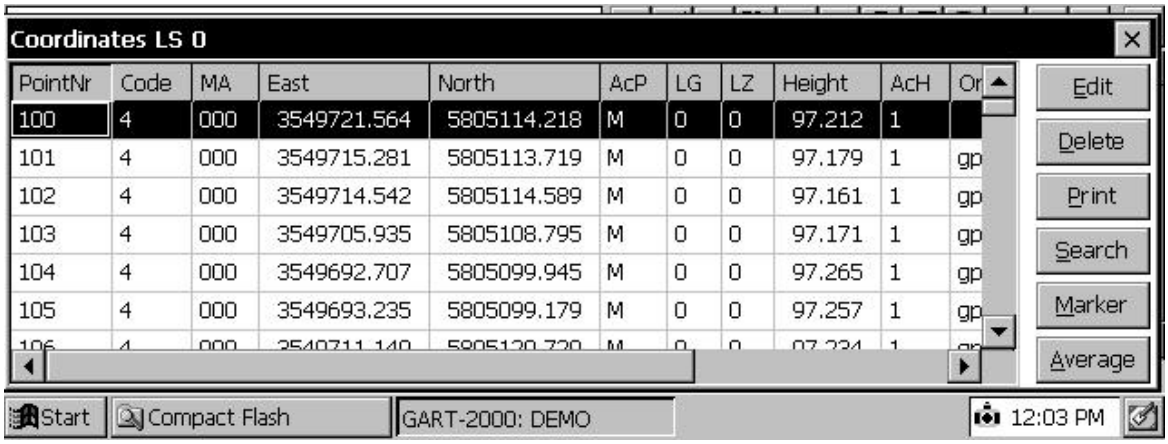


Figure 3-16: Output of Coordinates

Click on a row in the list and press the button **<Edit>** to edit the point.

To delete specific points, press the button **<Delete>**.

Press the button **<Print>** to output the coordinates into a log file.

To search for a specific point use the button **<Search>** and enter the point number or click on the point in the graphic screen.

Press the button **<Marker>** and enter the point number, point code, marker type, easting, northing, height, accuracy level of the position and height and a commentary.

Those points, which were selected by the Space-Key or by the function **<Marker>**, can be averaged after pressing the button **<Average>**. They will be stored as debit plane coordinates. If coordinates are marked, which have different point numbers, just the marked coordinates of the first point will be taken over into the dialog “Average coordinates”.

Press the button **<Pan>** to center the graphic screen on a selected point. This point can be selected in the graphic screen or in the coordinate output list (supported only in ***GART-2000® NT / Viewer***).

Activate **<Zoom>** to zoom on a selected point (supported only in ***GART-2000® NT / Viewer***).

3.9 Local Transformation

To calculate a local transformation, choose the ***Input > Coordinates*** submenu and enter the coordinates and point numbers of the control points.

When measuring the control points in the ***Input > Measurements*** submenu, make sure to use the same point numbers as entered before. Once you have measured your identical points, it is possible to calculate a transformation. Choose the ***Calculate > Polar/GPS-Transformation*** submenu.

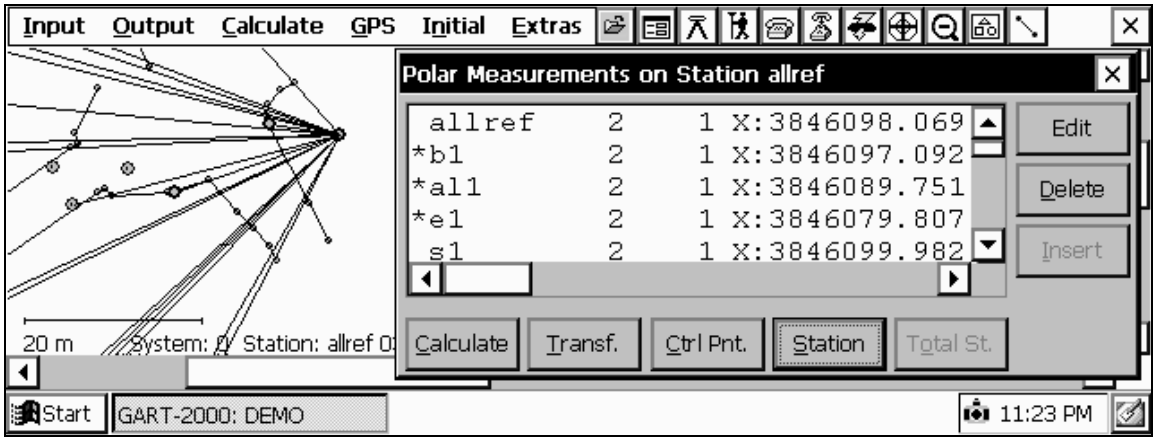


Figure 3-17: Polar/GPS-Transformation

First choose the kind of transformations with the ***Transf > Change*** button. To perform a standard local adjustment, use a 3-Parameter-Transformation without residual estimation.

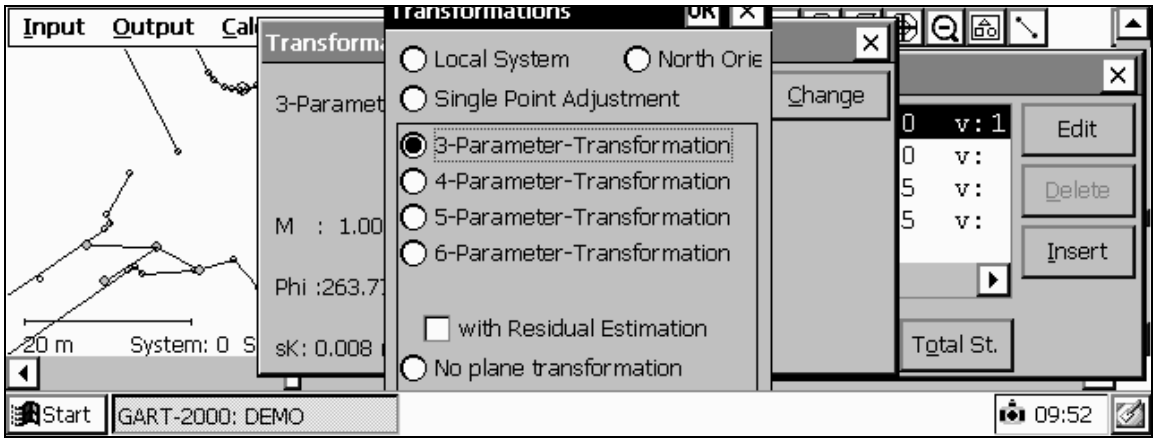


Figure 3-18: Kind of Transformation with Total Station

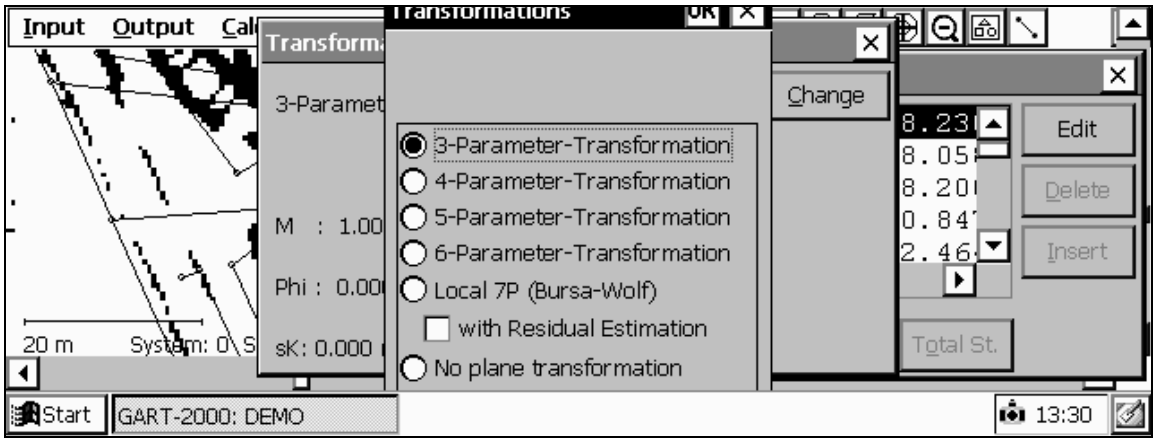


Figure 3-19: Kind of Transformation with GPS-Station

Subsequently, the control points can be selected using the **<Ctrl Pnt>** button.

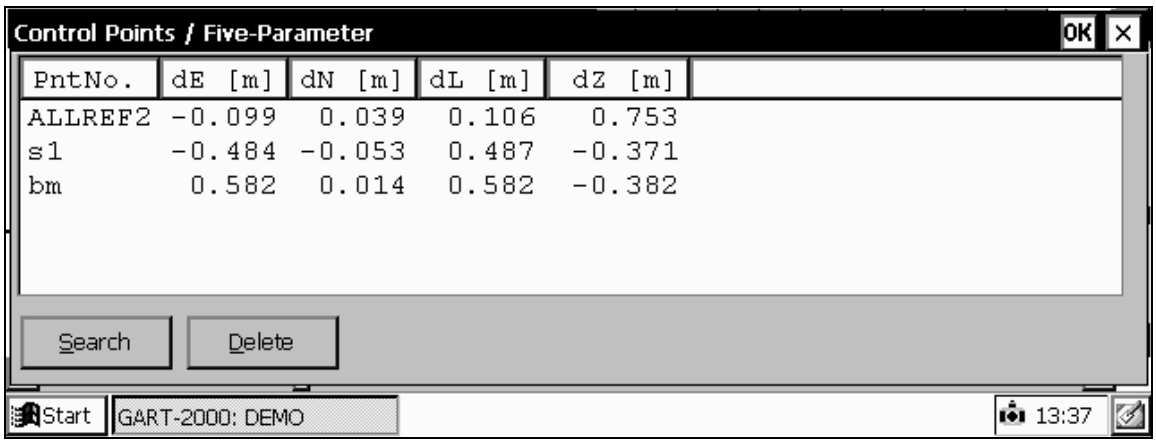


Figure 3-20: Control Points

Only those points are shown here whose measurement values have already been designated as control points. To this end, the respective measurement value is edited in the window ***Output > Measurements*** and the checkbox **<CP>** is activated.

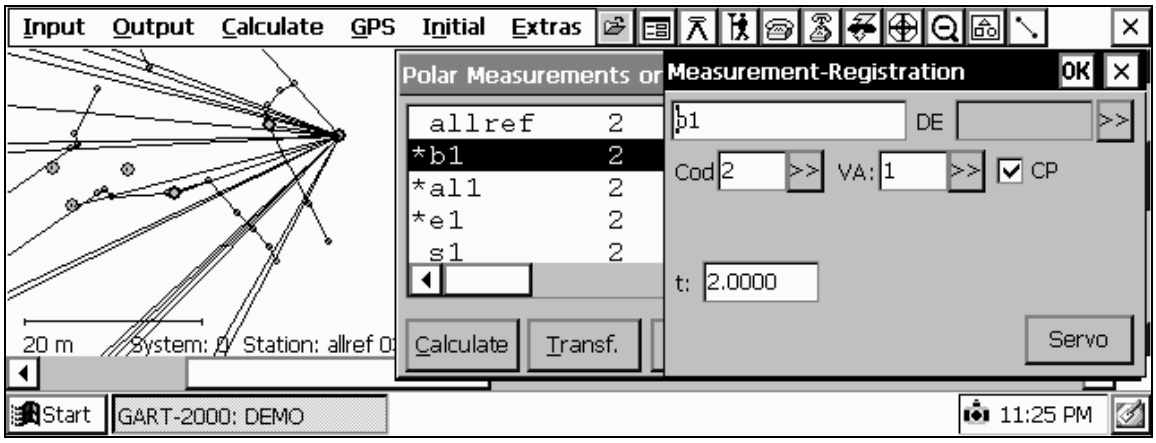


Figure 3-21: Edit Measurements

The transformation laid down via the control points has a direct effect on the calculation of the user coordinates and is saved in relation to the station. That means that the coordinates for all the measurement values saved under a specific station are calculated using the 7-parameter transformation chosen in ***Inital > Constants > GPS,*** the projection and the local

transformation chosen here. After the control points have been entered, the transformation calculation for all points of a station is carried out via the **<Calculate>** button. All new subsequently measured points are automatically transformed. Any deviations from the nominal coordinates are also displayed.

With the exception of the control points, the transformation accesses the measurement values and not the coordinates in the user coordinate system. For this reason it is important to delete both the coordinates and the measurement values for any incorrectly saved points prior to the transformation!

For a new station the old transformation cannot be applied. Optionally, a new transformation can be defined.

4 Menu Control

This chapter follows the menu structure of ***GART-2000® CE***:

4.1 Input
4.2 Output
4.3 Calculate
4.4 GPS
4.5 Initial
4.6 Extras

4.1 Input

4.1.1 Stations

Before performing any kind of measurement in ***GART-2000® CE*** a station has to be defined. A basic principle of ***GART-2000® CE*** is the attachment of measurements to a station. For GPS the location of the Base receiver is a station. The station-concept enables the user to apply different transformations in one project and therefore is the key to the integration of total stations and GPS in ***GART-2000® CE***.

Use the menu ***Input > Stations*** to setup a station. After the first initialisation of the station in a new project ***GART-2000® CE*** uses this station automatically.

The function displays a list of all available stations in the project.

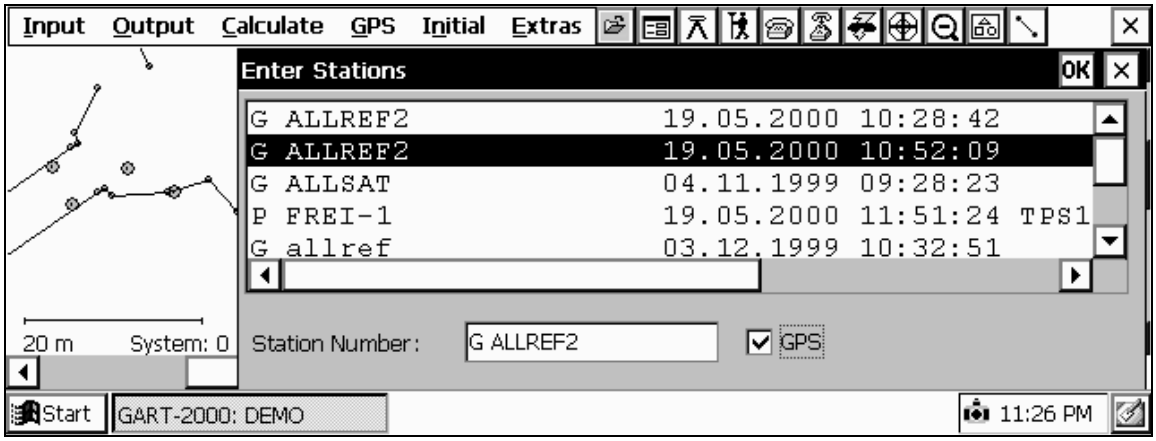


Figure 4-1: Enter Stations

Enter the name of a new station in the field **Station number** or choose an already existing station by double-clicking in the list. If you enter a new GPS station make sure to activate the **<GPS>** checkbox.

If a new station is created additional data may be entered:

- **Code:** point code
- **MA:** marker type
- **Instr.Height:** antenna height
- **CP:** if the station is to be used as a control point this checkbox has to be activated.
- **System:** to work with different systems during a project choose the actual system for this station. All coordinates of measurements that relate to this station are stored in this system.
- **Instrument:** choose Total Station

Location, Observer and Weather are additional information, which are useful for the documentation of a project.

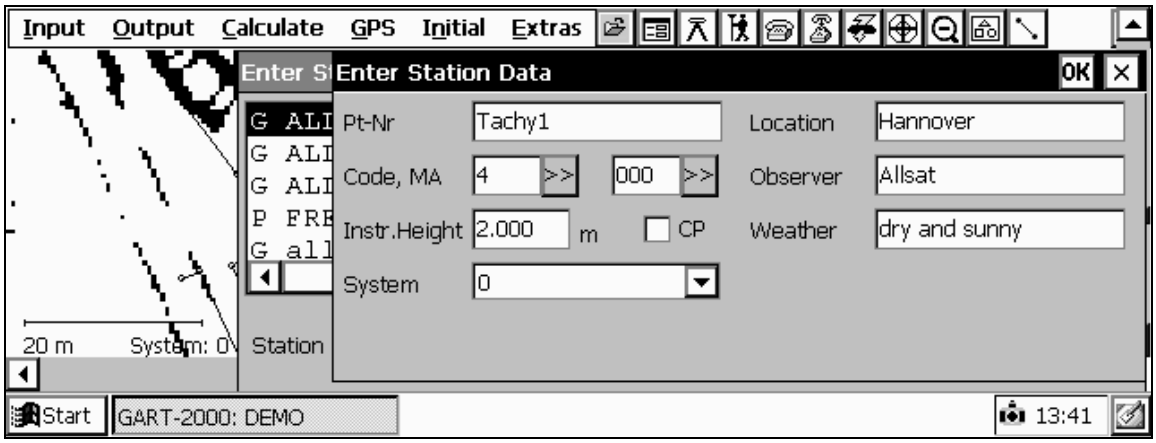


Figure 4-2: Enter Station Data (GPS)

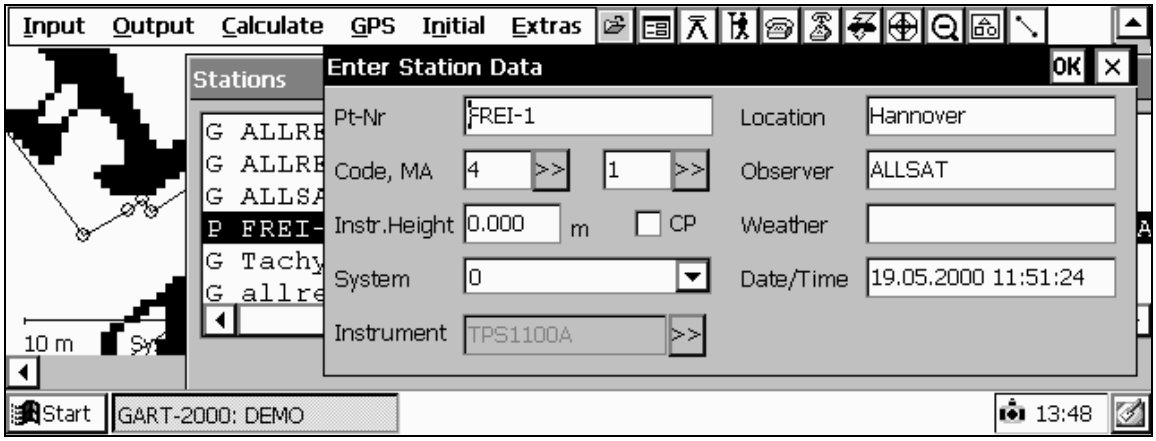


Figure 4-3: Enter Station Data (Total Station)

With the **<OK>** button the station is stored.

GART-2000® CE automatically changes into the menu ***Input > Stations***, after first initialisation of the receiver in a new project or after the first initialisation of the reference base.

After a station has been entered, ***GART-2000® CE*** automatically calls up the measurement registration (recording of the measurement values).

4.1.2 Measurements

In the submenu ***Input > Measurements*** the GPS or Total Station measurements are shown and stored. The functionality of the Measurements dialog depends on the current selected station (GPS or Total Station).

The menu can also be opened with the button shown above.

4.1.2.1 Total Station

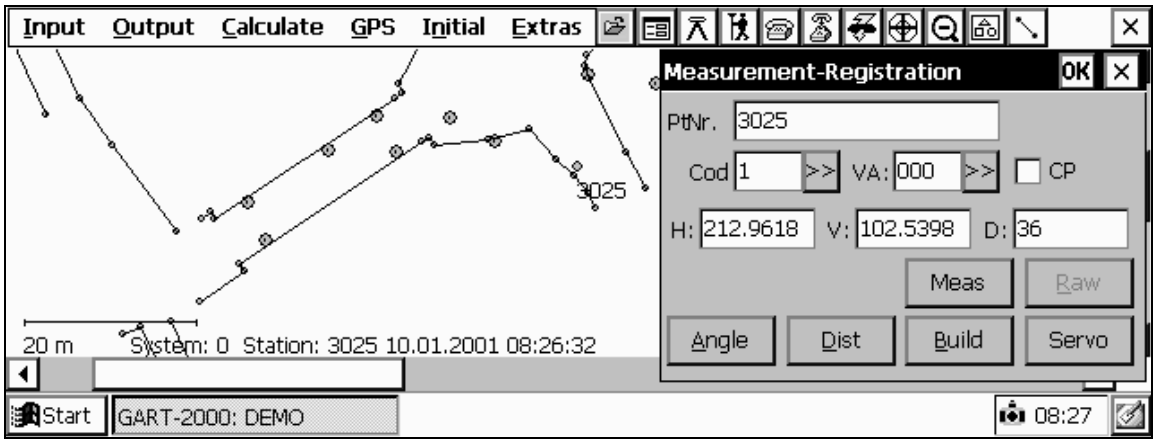


Figure 4-4: Measurement dialog for Total Station control

In this window the total station measurements have already been corrected in terms of the instrument constants entered under ***Initial > Instrument***.

In the field **PtNo**. enter the designation of the point to be measured. In the field **Cod** you can allocate the point code and the marker type is specified in the field **VA**. **<CP>** characterizes the point when it is activated as a control point. **H** specifies the horizontal angle, **V** the vertical angle, and **D** the distance.

The measurement is triggered via the appropriate buttons. The button **<Meas>** initiates the angle and distance measurement. By means of the button **<Raw>** a coarse measurement is initiated with a shorter measurement period yet with reduced accuracy. The buttons **<Angle>** and **<Dist>** only deliver the angle or the distance and vertical angle respectively. **<Build>** is conceived for measurements using reflectors in the case of buildings. The current status of the measurement is shown in the title bar. After the measurement has been successfully carried out, the dialog switches into the save mode.

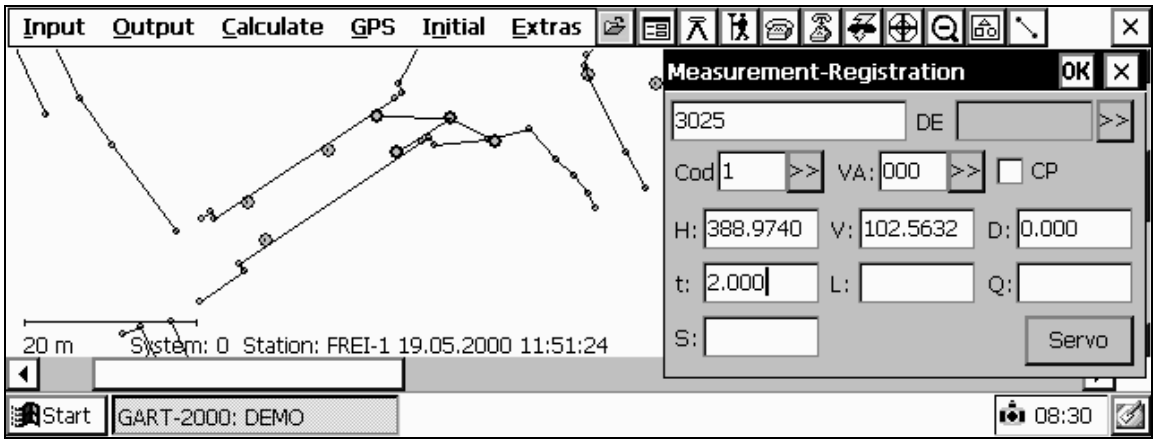


Figure 4-5: Registration of Measurement

After the measurement elements have been registered, the target height **t**, the longitudinal ex-center **L** (set to 0.2 m in the case of building measurements), the transverse ex-center **Q** and the distance eccentricity **S** are entered in meters. You can save the measured values with **<OK>**, or reject them with **<X>** and return to the previous dialog.

Servo-driven instruments can be controlled by the button **<Servo>**.

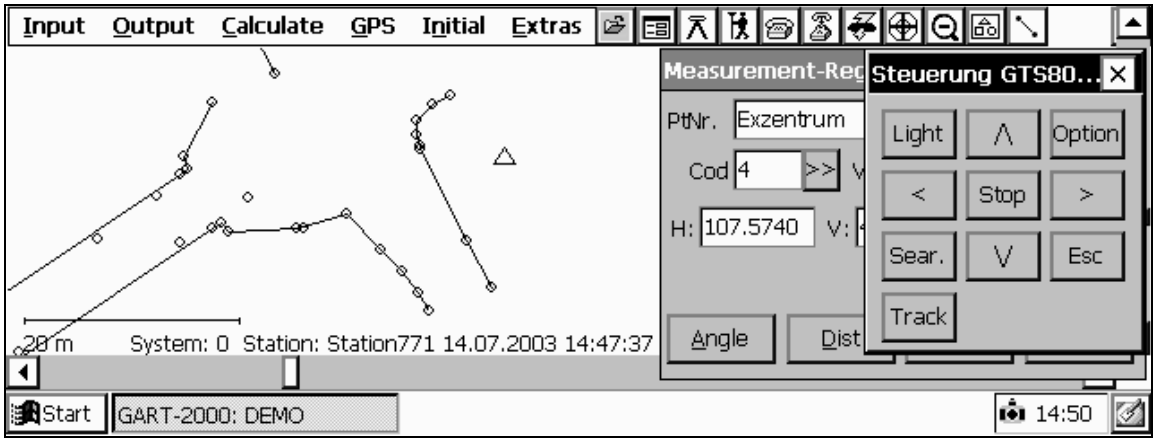


Figure 4-6: Servo Control

In the case of servodriven total stations you can rotate and tilt the total station with the ◄ ▲ ► ▼ buttons and halt the process with the **<STOP>** button.

The **<Light>** button switches on the light on the tachymeter so that it can be seen from a long way off as well.

Further special functions can be set via **<Option>**.

The **<Search>** button starts an automatic search for the reflector.

By pressing the **<Track>** key, the Tracking Mode can be switched on or off. This allows the prisma to be followed automatically and thus enables, for instance, the simple setting out of a point previously entered in ***Enter Coordinates***.

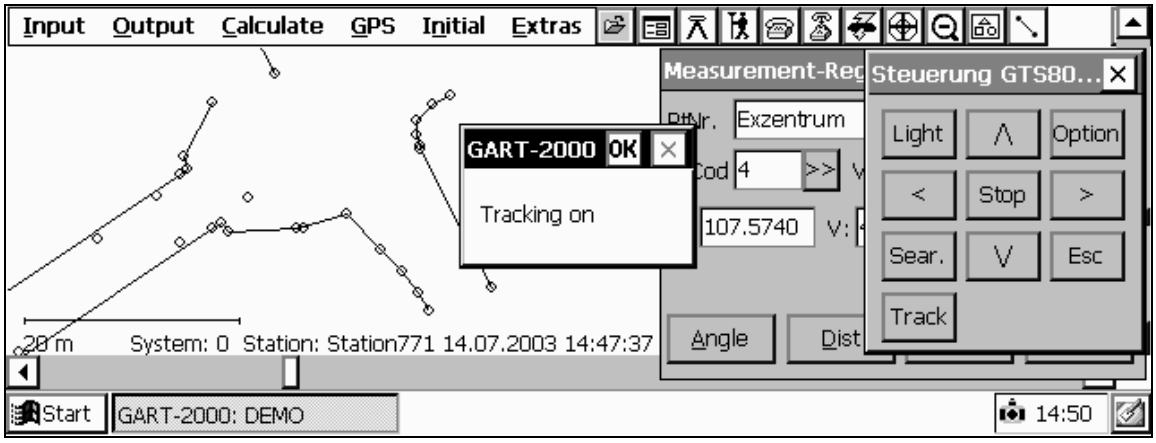


Figure 4-7: Tracking Mode on

With the aid of the **<Radio>** button, you can switch between RC 2 Search Mode and standard cellular devices in the case of Topcon tachymeters.

Pressing **<Esc>** or **<X>** returns you to the previous window.

4.1.2.2 GPS

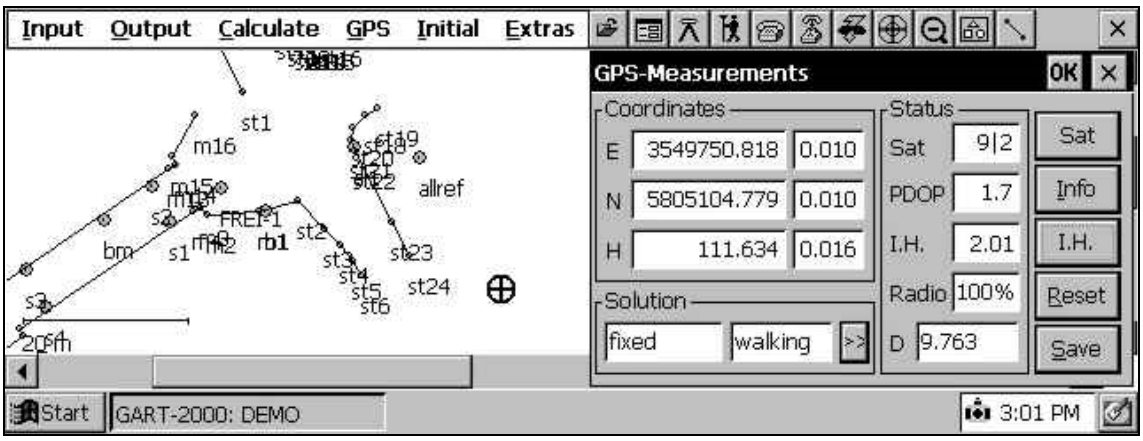


Figure 4-8: GPS Measurements

The following GPS-Measurements data are displayed:

E	East-coordinate in the user system with the standard deviation [m]
N	North-coordinate in the user system with the standard deviation [m]
H	Height of the coordinate in the user system with the standard deviation [m]
Sat	Number of satellites used for the position calculation (GPS | GLONASS)
PDOP	PDOP: factor to determine the reachable accuracy dependent on the satellite geometry.
I.H.	Antenna height (true vertical height of phase center above the ground point)
Radio	Display of the radio link quality
D	Distance to the reference station in [m]
Solution	Display of the ambiguity fixing status and the chosen dynamics of the GPS-Rover receiver.

The status of ambiguity fixing may be the following:

- ***fixed***: PDGPS-solution with fixed ambiguities.
- ***float***: PDGPS-solution with code and carrier-phase corrections.
- ***Code diff***: DGPS-solution with code corrections.
- ***autonomous***: autonomous position of the receiver.
- ***invalid***: position calculation impossible.

The calculation of the ambiguities in the GPS receiver is influenced by the chosen dynamics. The dynamics describe the movement of the GPS antenna.

Pressing the **<Reset>** button restarts the determination of the ambiguities. Once these have been calculated, the text ***"fixed"*** appears***.***

By pressing the **<Save>** or the **<OK>** button, the current coordinates can be saved. ***GART-2000® CE*** can average several measured values in the process. The number of measured values to be averaged can be set under ***Initial > Constants > GPS***. The standard deviation displays results from the averaging of the measured values.

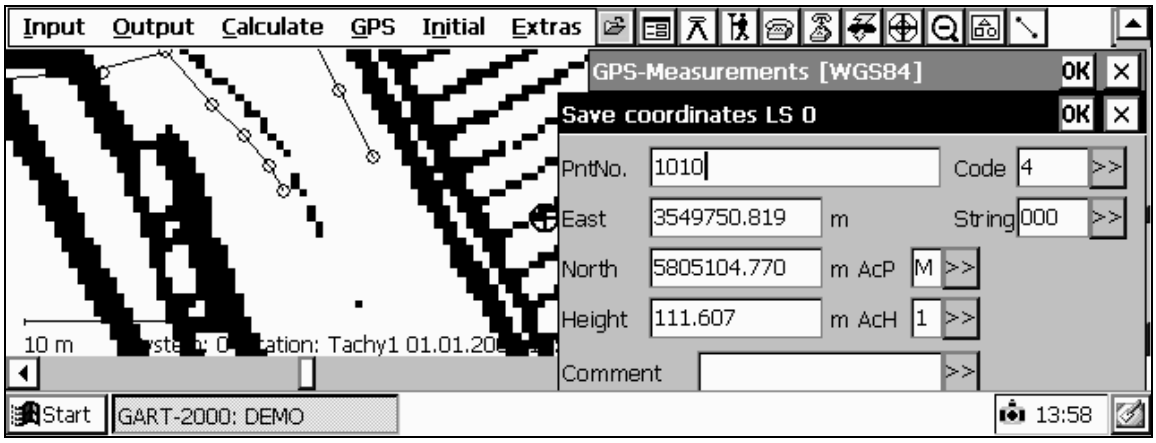


Figure 4-9: Saving GPS-Measurements

The point number can be entered after the calculation of the average, whereby ***GART-2000® CE*** increments the point numbers. As well as the coordinate, the point code, marker type and a commentary are also saved. In addition, the accuracy level of the position (**LG)** and height (**HG)** and the reliability level of the position (**LZ)** and the height (**HZ)** can be changed for cadastral applications. The measurement value is saved with **<OK>**.

With the button **>>** the dynamics can be chosen from a list.

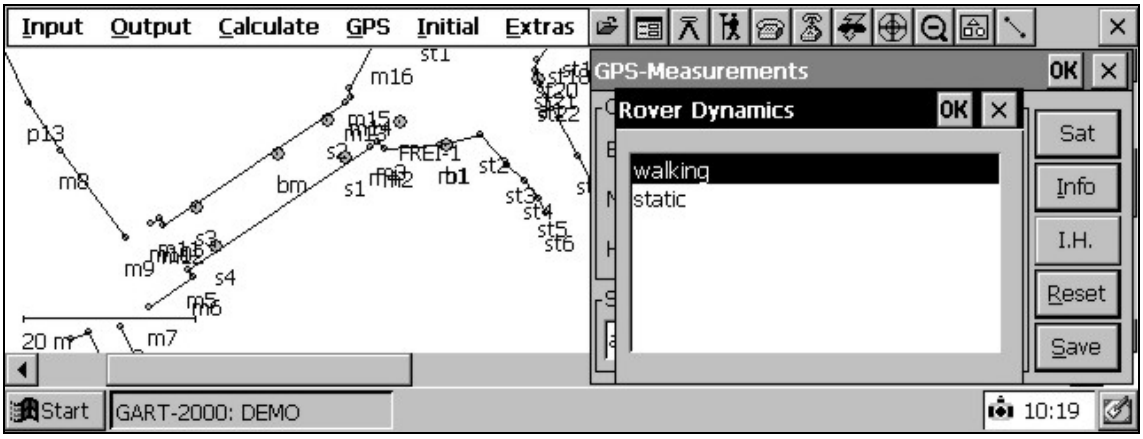


Figure 4-10: Dynamic

Possible settings for Topcon are **"*static"*** and "***walking".*** For Ashtech-receivers there are ***"quasistatic", "walking", "automobile" ,"aircraft"*** and **"*ship"*** additions.

The button **<Sat>** displays detailed information about the tracked GPS/GLONASS satellites.

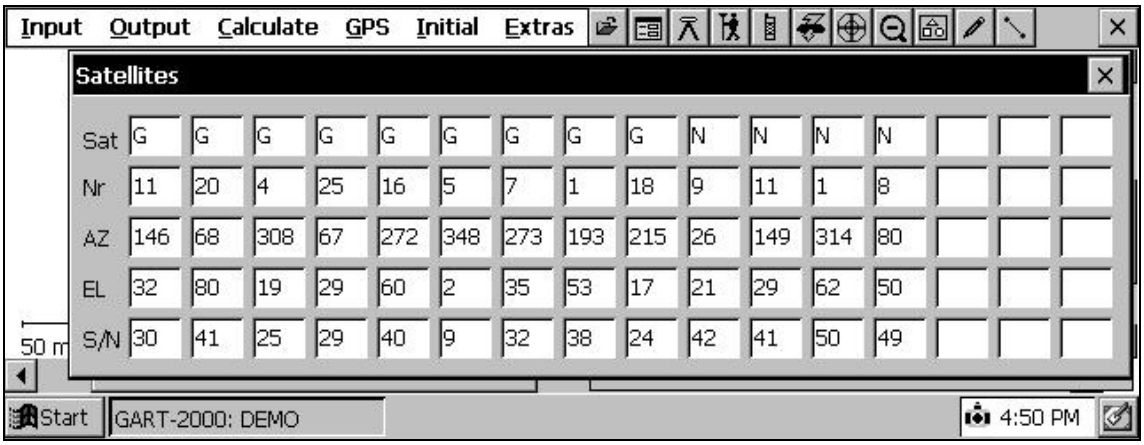


Figure 4-11: Satellite Overview

The satellite overview displays the satellite number, the azimuth, the elevation and the signal/noise-ratio of the different satellites on the screen. For Topcon-receivers the GPS satellites are marked with a ***'G',*** GLONASS satellites with a ***'N'*** in the first row. For Ashtech receivers you will see a flag (***'-'*** or ***'U'***). The satellites are marked with a 'U' if differential corrections exist for a satellite. Otherwise, a **'-'** is shown.

The button **<Sky-Plot>** shows the actual satellite geometry.

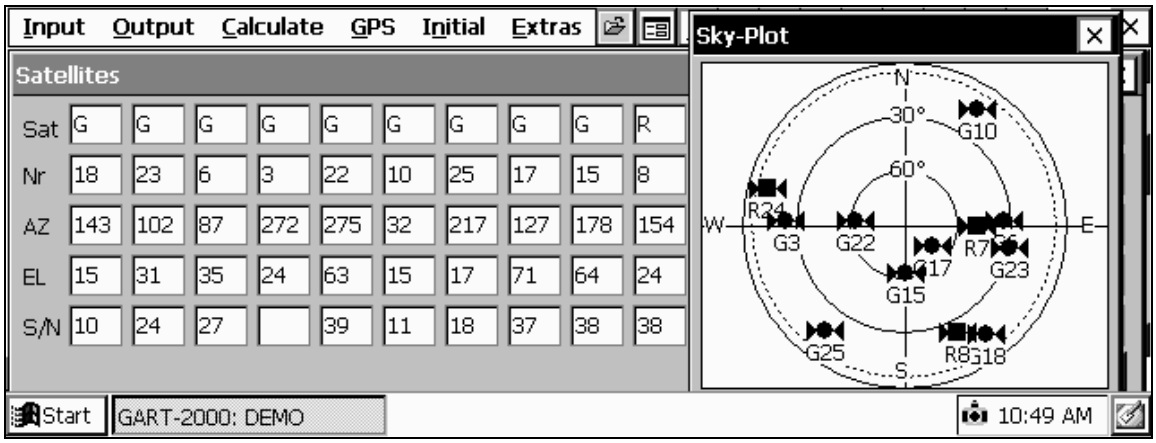


Figure 4-12: Satellite Geometry in Sky Plot

The **<Exc>** key enables the simultaneous measurement with an MDL or tachymeter and GPS. This facilitates the measurement of excentres where GPS measurement is not feasible.

After the **<Exc>** key has been pressed, a **PntNo** must be specified designating the excentre to be measured.

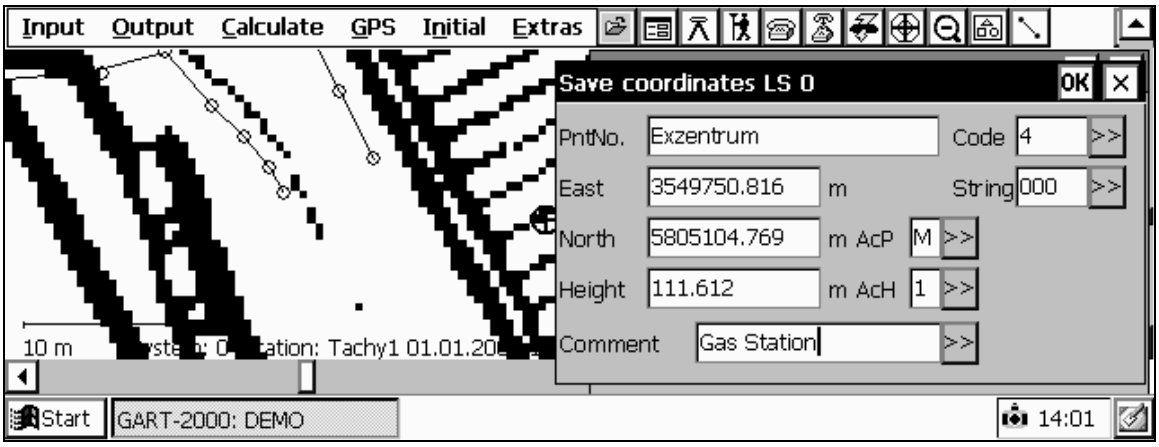


Figure 4-13: Saving Exzentrum

After the **<OK>** key has been pressed, the Measurement Registration window opens up for the recording of the polar measurements.

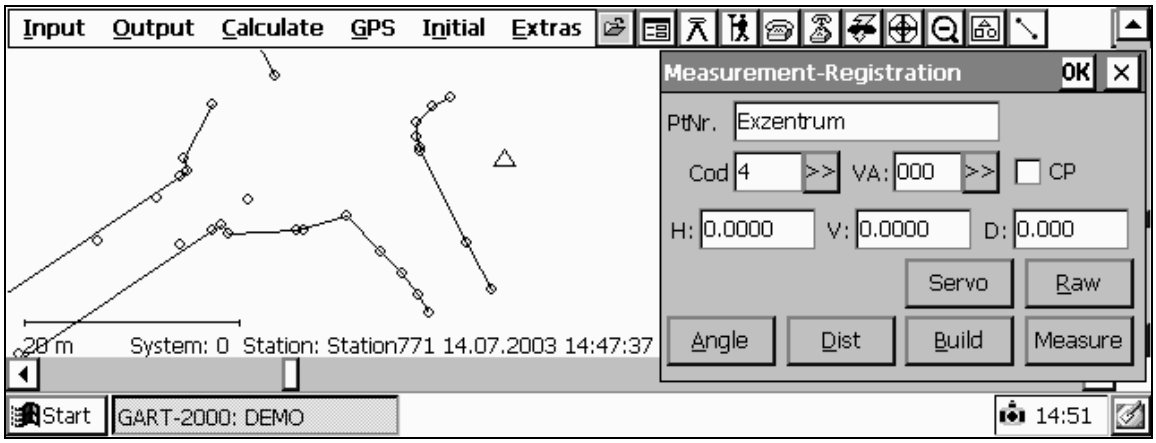


Figure 4-14: Measurement Registration

The **<Measure>** button is pressed to initiate the measurement.

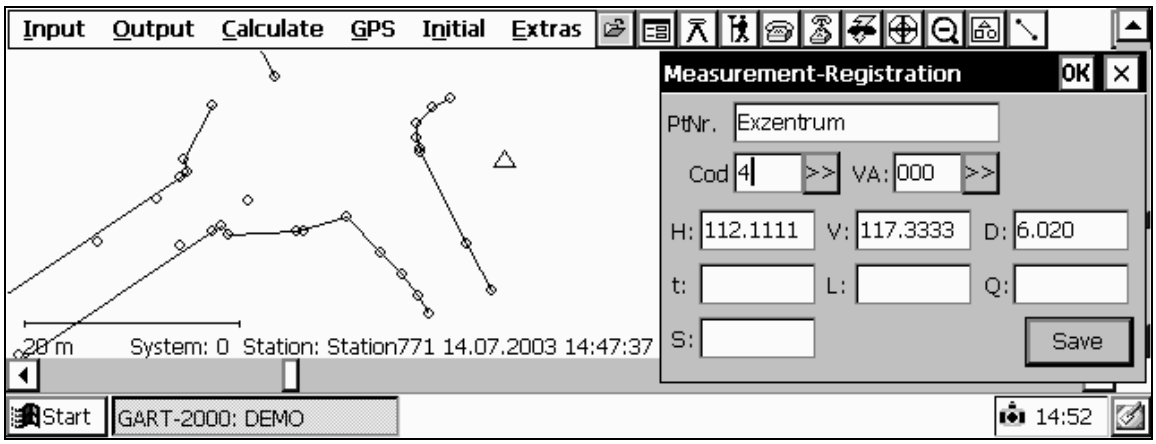


Figure 4-15: Measurement Registration

In the case of the MDL, the instrument height must be entered in the field **<t>** with a negative algebraic sign. The measurement result is saved by means of **<Save>**.

By pressing the **<Info>** button, a button strip is shown; if pressing these buttons further information from the GPS receiver are queried.

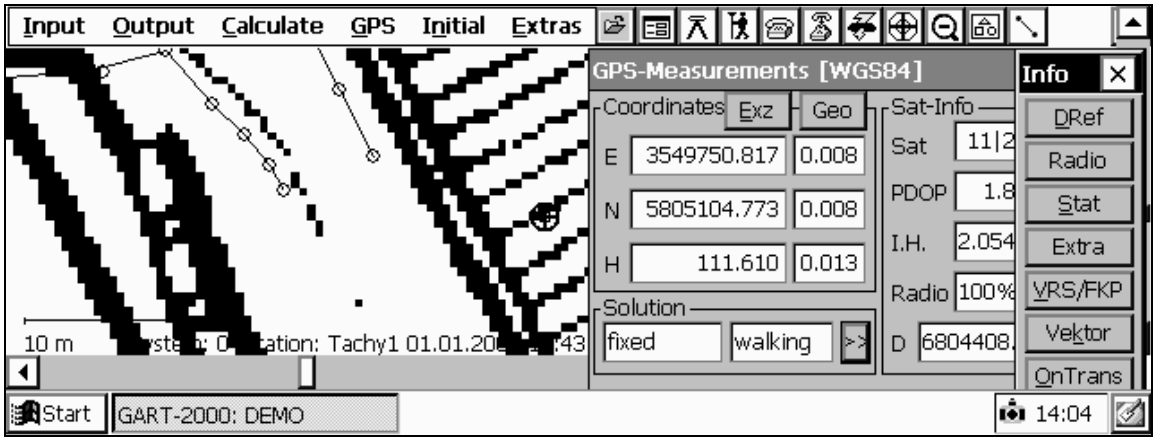
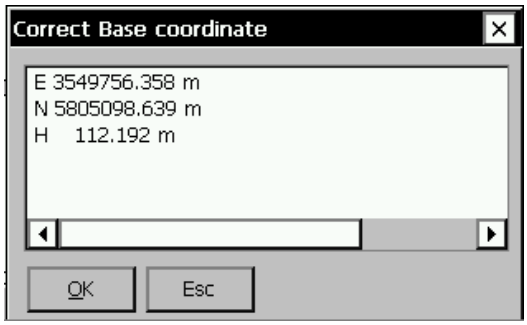
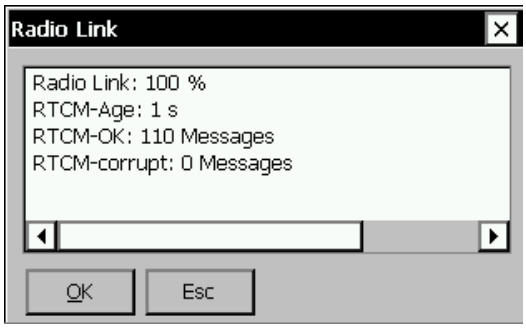
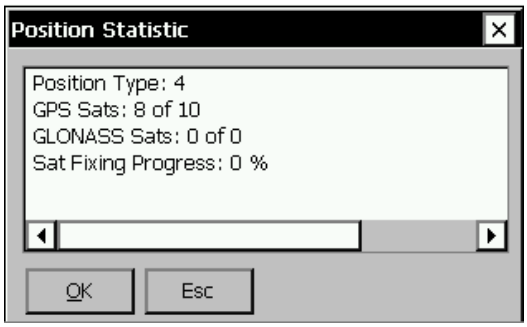
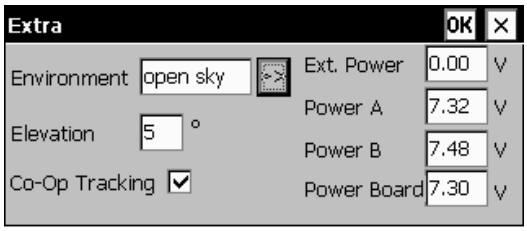
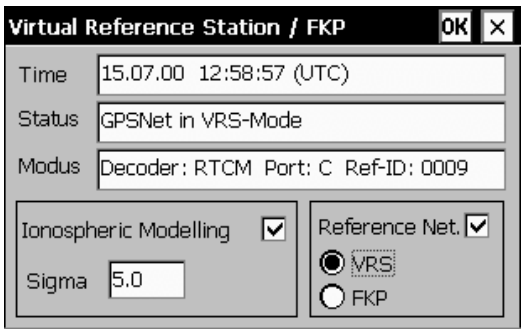
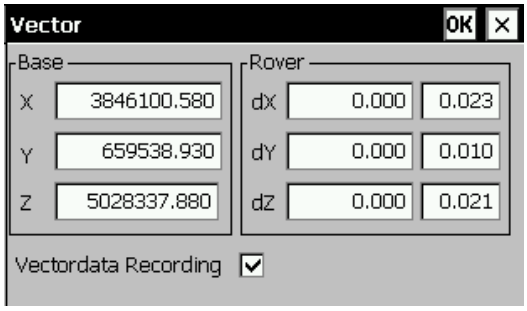
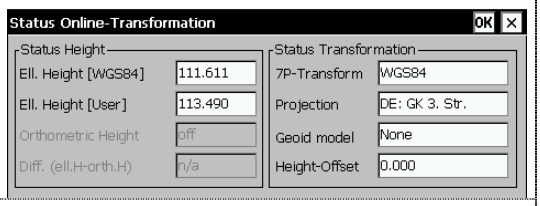
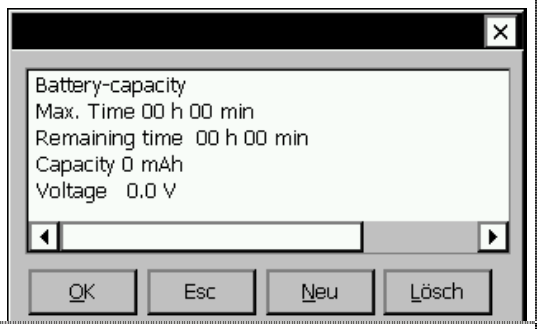
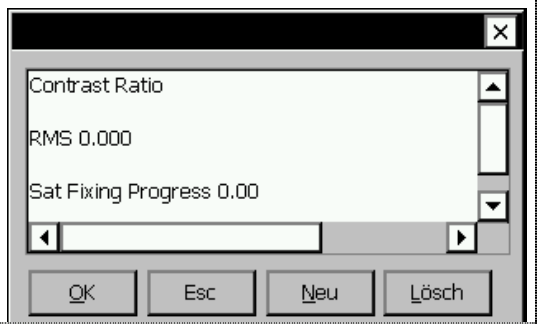


Figure 4-16: Info buttons for more information (here: Topcon)

The following functions are supported:

<Dref>	This function reads the coordinates of the Base receiver from the RTCM messages and saves it. These coordinates are used to calculate the distance from the Rover to the Base receiver (D). If vector data recording has been set, the distance display is updated automatically.	
<Radio>	The status of the received correction data is displayed. *Ashtech-receivers:* - RTCM-Age: Age of the differential corrections in seconds. - RTCM-Quality: Display of the radio-quality in percent. - Data: Flag to show the data: '**+**' Data are okay '**-**' No reception. In addition, the satellites for which differential corrections are received are shown in the screen. *Topcon-receivers:* - Radio Link: Display of the radio quality in percent. - RTCM-Age: Age of the differential corrections in	

	seconds. - RTCM-OK: Number of correct received sets of differential corrections. - RTCM-corrupt: Number of incorrect received sets of differential corrections.	
<Stat>	Statistics about the position calculation. (Topcon)	
<Extra>	Possibility to change the elevation mask and the environment type. ***"Open sky"*** should be selected as the standard environment here. In the field **Elevation** a degree figure can be entered to specify the minimum elevation of the satellites used to calculate position. The checkbox **<Co-Op Tracking>** enables the control of Co-Op Tracking. **Ext. Power** displays the present input voltage of the receiver. **Power A** and **Power B** indicate the voltage of the internal rechargeable batteries A and B (only relevant to Hiper and Odyssey-E from Topcon). **Power Board** provides information on the voltage that exists on the board.	
<VRS/FPK>	Settings can be made here pertaining to the use of a virtual reference station. Date and time are specified in the field **Time**, network status in the field **Status** and receiver information in the field **Mode**. **Ionospheric model:** Activate this module if the ionosphere is disturbed. According to strength, set the **Sigma** parameter between 5 and 10. **Reference network:** By activating this checkbox, you specify that you are measuring within a reference network (e.g. ***ascos***, SAPOS).	

	VRS: Virtual Reference Station *FKP: Area Correction Parameter*	
<Vector>	The absolute coordinates of the Base are displayed in Cartesian coordinates as well as the Base-Rover vector. By checking the checkbox **<Vector data recording>**, the correlations of the coordinates are also saved. The displayed distance **D** to the reference station is updated automatically. The vector data recording can be started with the aid of the Vector dialog. To this end, the corresponding checkbox should be checked. The Cartesian coordinate of the reference station is displayed in the **Base** fields, the vector between Base and Rover in the **Rover** fields.	
<OnTrans>	Status display for the online transformation (e.g. Trans-It, geoid models)	
<Power>	Indication of the battery capacity. This function works only for the Ashtech Z-Surveyor with internal battery. The voltage and the capacity as well as the maximum and remaining battery time are shown.	
<Contrast>	Indication of the Contrast Ratio Value. The contrast value declares how reliable the fixing of the ambiguities is. Ashtech: Range from 0.00 up to 999.0. A value higher than 1.0 indicates that the ambiguities are fixed.	

The button **>>** next to the field **Ant.Height** in the ***GPS-Measurements*** dialog opens the submenu for the Antenna height. Choose the manufactory and the antenna type. For each antenna type the individual antenna offsets are shown.

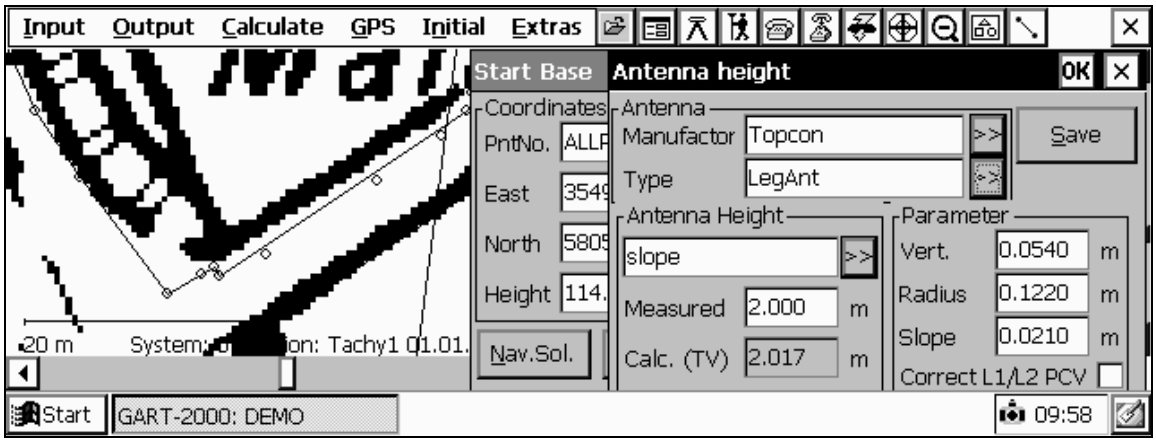


Figure 4-17: Antenna height

Enter the type of antenna height measurement:

"instrument height": measured from the marker to the bottom of the antenna at the base of the mounting threads,

"slope": measured from the marker to the lower edge of the groove around the antenna at the seam between the top and bottom halves of the antenna casing.

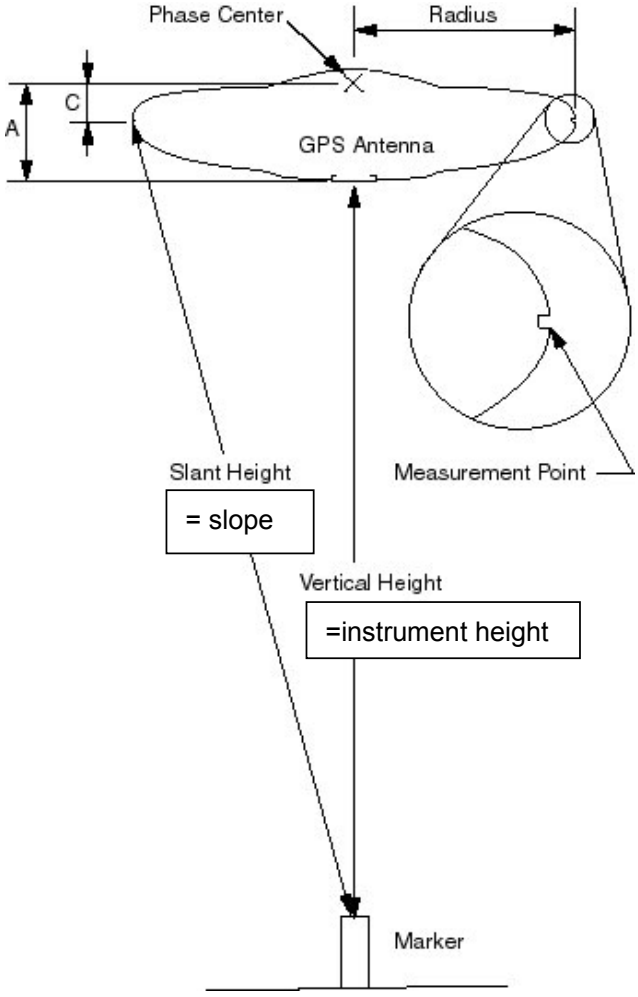


Figure 4-18: Antenna height measurement (from Topcon)

In the field **Measured** enter your slope or vertical antenna height. The true vertical height will be calculated immediately and will be shown in the field **Calc (TV)**. After exiting this window with the **<OK>** button, the true vertical height will be set as antenna height in the measurement window.

The true vertical antenna height in ***GART-2000® CE*** allows for different antenna offsets in case different antenna types are used on base and rover. In addition to the predefined antenna types in the list, you may enter your own antenna types. To do so enter a new name for your antenna and edit the values in the offset fields. The button **<Save>** stores the new entry.

By activating the checkbox <Correct L1/L2 PCV>, the offsets between L1 and L2 of the antenna phase center (North, East, Height) are sent to the reference station for the respective antenna type.

The **<X>**-button closes the measurement menu.

4.1.3 Tachymetric Set

The tachymetric set or total station measurement sequence is initiated by means of the menu function ***Input > Tachymetric Set***. The following dialog window appears:

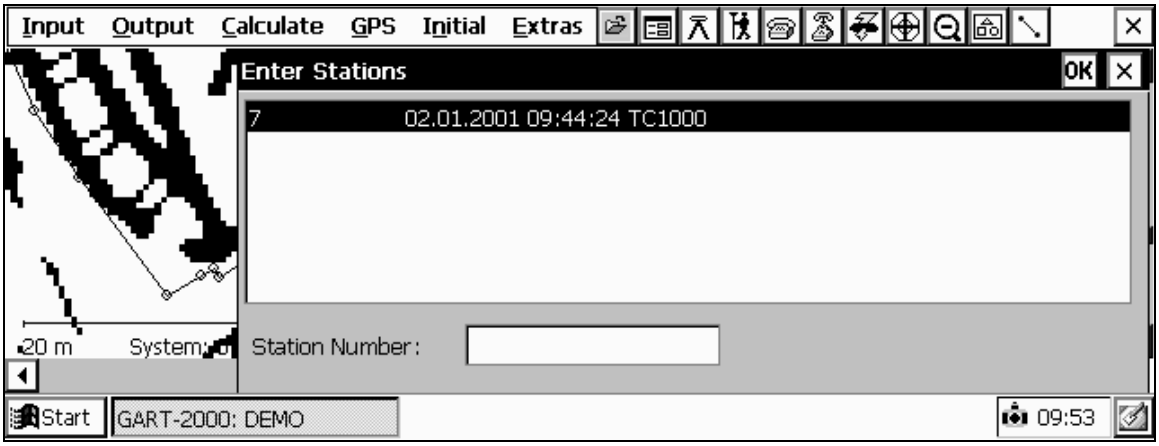


Figure 4-19: Dialog for station selection

Prior to each tachymetric set, a station must be selected or newly defined in this dialog. If the number of a new station is entered, ***GART-2000® CE*** switches to the dialog ***Enter Stations***. If these data are confirmed with **<OK>**, the Measurement Registration window - adjusted for the relevant tachymetric set - opens up for the selected station:

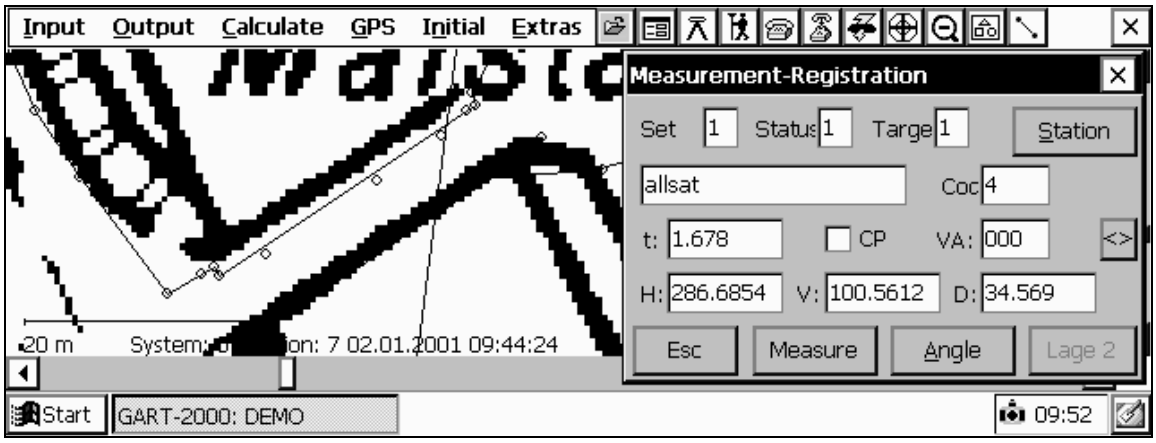


Figure 4-20: Measurement Registration

After the measurement in the direction of the 1st target of the first set has been triggered by the button **<Measure>** (measurement of all magnitudes) or **<Angle>** (angle measurement only) and the measurements have been subsequently saved with **<OK>**, the digit 2 is set automatically as the target. If the **<No Save.>** button is pressed, the measurement dialog is displayed once again and the measurement can be repeated.

When the measurement in the normal telescope setting (Face 1) has been completed, the measurement in the reverse telescope setting (Face 2) can be started by turning the telescope and re-measuring the last target. The further targets of the set are then presented in reverse order. Alternatively, the **<Face 2>** button can be clicked. When all the targets of the 1st set have been measured in both telescope settings, ***GART-2000® CE*** automatically proposes measuring the 2nd set.

By clicking the **<Station>** button, the values set in the dialog ***Enter Stations*** can be modified. During the tachymetric set measurement, the instrument constants for the axes are not applied since measurement is performed with two telescope settings.

4.1.4 Triple-Measurement

The module Triple-Measurement allows the usage of Triple-Prisms-Poles. Triple-Prisms-Poles usually contain three or two reflectors. They can be used for sloped measurements of a point and thus allow the measurement of inaccessible points, e.g., in canal shafts. If all reflectors have been measured, then the coordinates of the points can be determined through the know geometry of the pole. ***GART-2000® CE*** administers 10 Triple poles, which can be stored individually. Before a Triple pole is used, the calibration data must be entered.

This function is started over the menu order ***Input > Triple-measurement***.

First, a Triple pole needs to be selected. After confirmation you will reach in the measurement dialog. After entering the point number, point code and marker type up to three measurements can be executed to the prisms of the Triple pole by pressing the button <Measure>.

Under **<t >** the distance of the lower prism can be changed to the pole foot. This is necessary, e.g. if a lengthening is used or if the prism height is determined with a measuring instrument.

After the last measurement the calculations of the distances occur between the prisms. These are compared to the calibration data and the differences are calculated. If these differences lie within the tolerance, the measuring values are accepted.

4.1.5 Coordinates

There are different ways to enter coordinates into ***GART-2000® CE***. One possibility is to enter them manually; another possibility is to import coordinates from a file. With the coordinate input and output modules it is possible to exchange coordinates from one ***GART-2000® CE*** project to another. Consequently, there is the possibility of building up a fixed stock of coordinates and to import the needed coordinates into new projects from otherfiles.

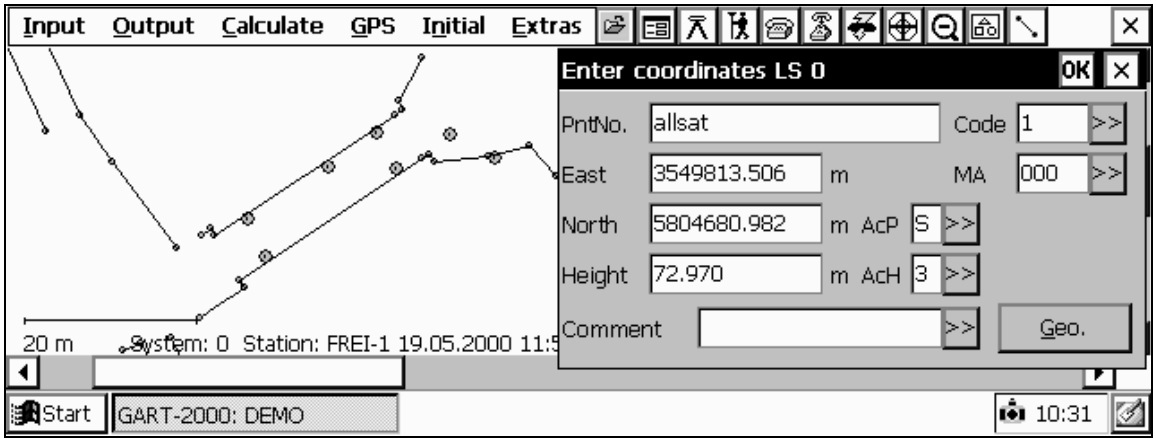


Figure 4-21: Enter Coordinates

Coordinates can be entered manually in the ***Input > Coordinates*** submenu. The coordinates have to be entered with respect to the projection defined in the ***Initial > Constants > GPS*** submenu (e.g. UTM or Gauss-Krueger).

The fields have the following meanings:

Pnt No	Point number (up to 32 alphanumerical characters)
Code	Point code (can be changed in the file *vp_art.txt*)
MA	Marker type (can be changed in the file *vp_vmrk.txt*)
East	East-coordinate in the user system [m]
North	North-coordinate in the user system [m]
Height	Height in the user system [m]
AcP	Precision of the position calculation: 0 - no position D - digitized point M - measured point R - calculated point S - control point
AcH	Precision height calculation: 0 - no height 1 - Order 1 (lowest order, e.g. total station measurement) 2 - Order 2 (medium order) 3 - Order 3 (highest order, e.g. height control point)

Field **<Comment>** for additional point information. Every commentary entered is saved in a list and can be selected from this list once again when the next point is entered.

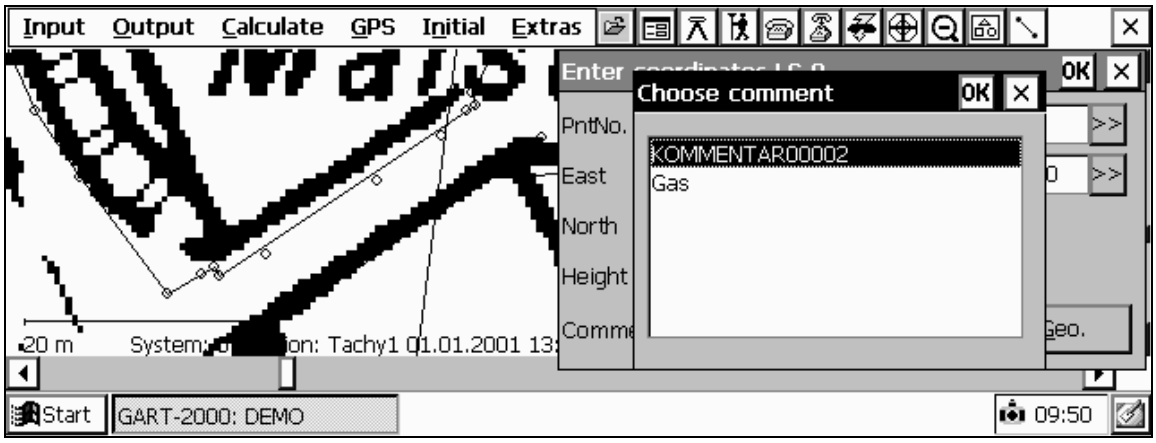


Figure 4-22: Choose Comment

The coordinates can be entered either in plane or, using the button **<Geo.>,** geographical (WGS84) mode. A conversion between user-coordinates and geographical mode is done automatically when switching between the modes. Please note that the current selected user coordinate system in the ***Initial > Constants > GPS*** submenu is applied for the conversion.

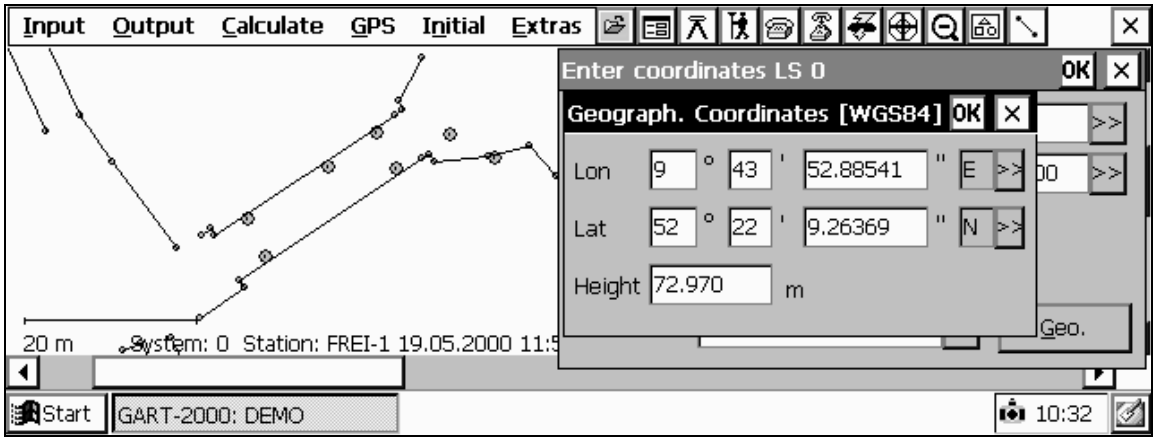


Figure 4-23: Enter geographical Coordinates

For information about coordinate import from files see ***Input > Import***.

4.1.6 Graphical Coordinate

The menu item ***Graphical Coordinate*** enables the digitization of points (e.g. on a georeferenced bitmap map imported into the project).

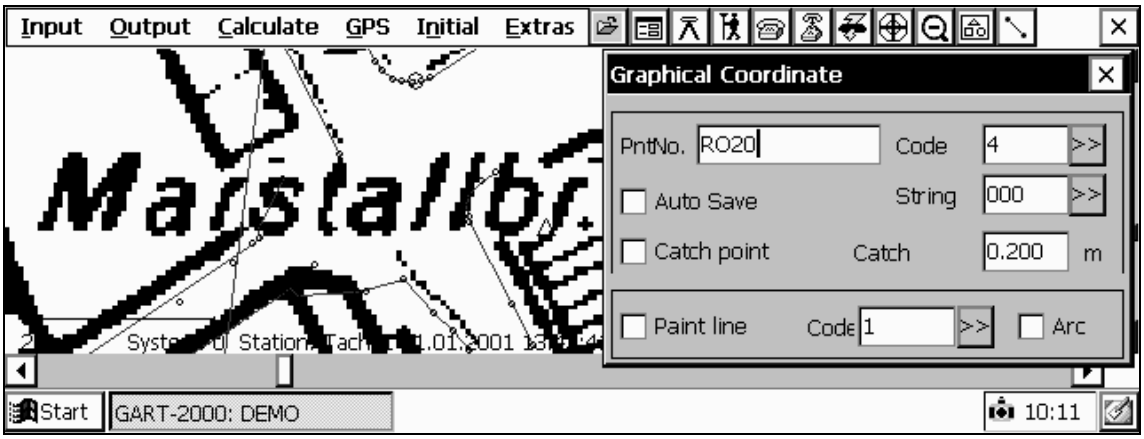


Figure 4-24: Enter graphical Coordinate

The point number is entered in the field **<PntNo.>**.

In the fields **<Code>** and **<String>** a point code or marker type proposed in the selection list can be chosen.

By clicking the field **<Auto Save>**, the coordinates of the points digitized in the graphic are saved immediately. By clicking the field **<Catch>**, a point located within a radius defined in the field **<Catch>** is captured in the graphic.

The digitized points can be connected with lines. This is effected by clicking the field **<Paint line>.** Here, a line type can be selected and the **<Arc>** option can be clicked. If the **<Arc>** option is activated, a circle is drawn through three digitized points.

If **<Auto Save>** has not been activated, the point number, point code, marker type and commentary can be entered manually.

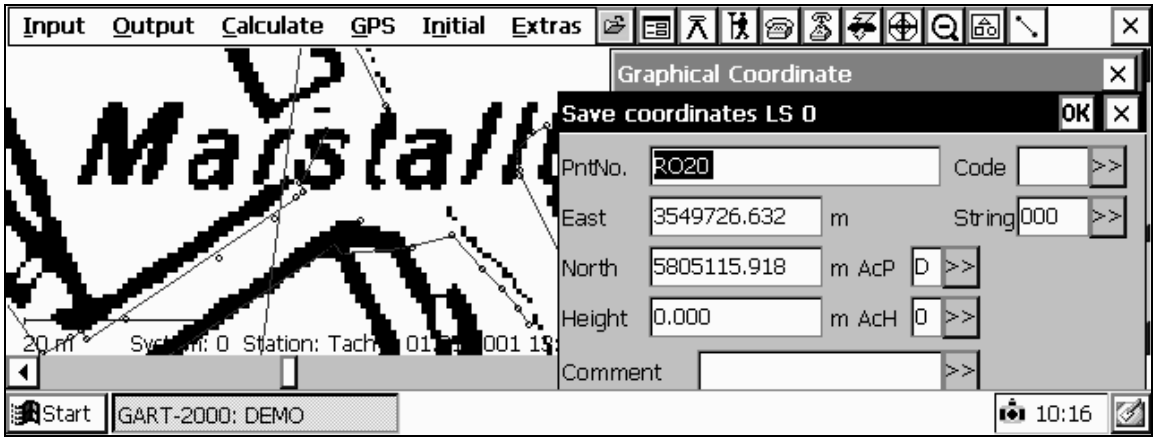


Figure 4-25: Save graphical Coordinate

4.1.7 Struts

If you want to measure struts with a total station, this works from any station by measuring the distance beginning point and distance ending point. Then the diameters are calculated from directions and distances. In this window you can select a Total Station.

To start the tachymetric measurement of struts click on Input > Struts. The following dialog appears:

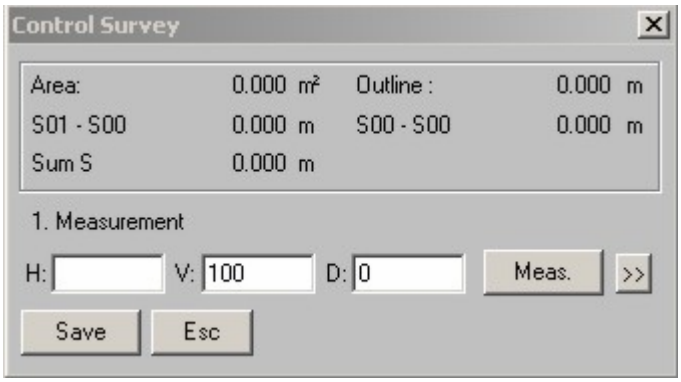


Figure 4-26: Control Survey

The first measurement takes place to the distance beginning point. Click on the button **<Meas>** and register with the button <**Save>**. For the second measurement target the distance ending point which is also the beginning point of the second strut. If you are measuring again the start point, then the area and surrounding diameter is automatically calculated.

This button „**>>"** activates the extended control functionality for automatic total stations.
With **<Esc>** you can leave the menu.

4.1.8 Lines

With the button shown above or the menu ***Input > Lines*** the following window is opened:

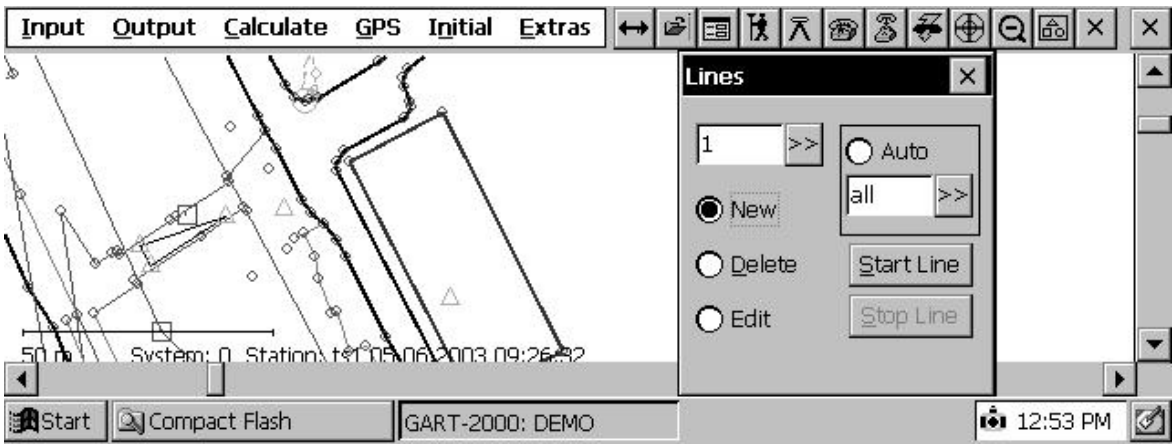


Figure 4-27: Creating Lines

By clicking the button **>>** a list of line codes is opened. The selection list can be modified or extended in the file vp_lart.txt.

To draw a line between two points choose the radio button **<New>**, press the **<Start Line>**-button and click on the start and end point of the line. To stop the drawing of a line, press the button **<Stop Line>.** To remove a line activate the radio button **<Delete>** and double-click the respective line. If the **<Auto>** checkbox has been activated, the points saved via GPS or tachymeter are automatically connected by lines. With the **<Change>** radio button the code of the line can be changed. If the selection ***"only identical"*** has been made, the mouse arrow jumps to the next point that has the same point code. The **<Edit>** button enables the line type of an existing line to be changed.

4.1.9 Notes

With the button shown above or the menu ***Input > Notes*** the following window is opened:

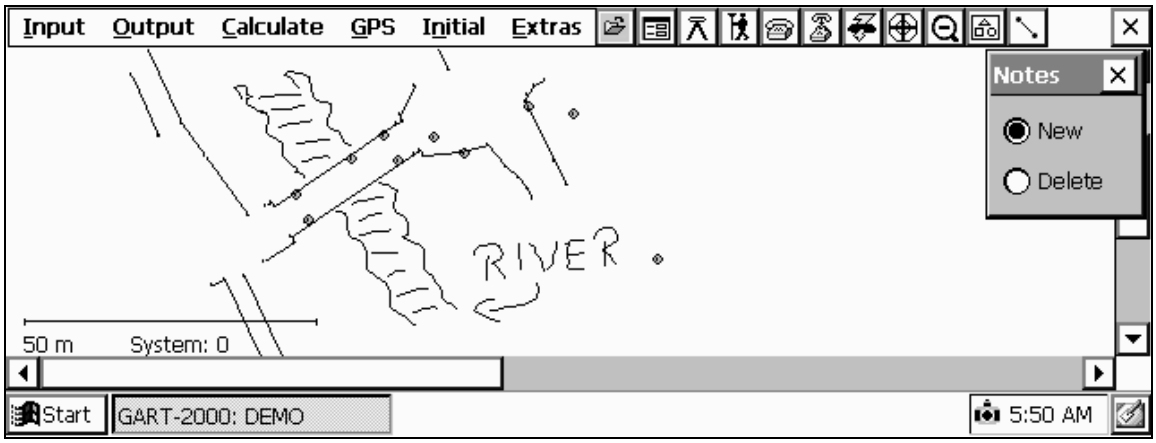


Figure 4-28: Using Notes

With the checkbox **<New>** it is possible to write notes directly - with the pen - into the screen. Such notes are very helpful during the revision of the project. You can remove the notes by marking them with the mouse arrow and choosing **<Delete>.** The notes are saved in accordance with the scale.

4.1.10 Import

With the menu ***Input > Import*** it is possible to import data from other programs; ***GART-2000® CE*** converts these data automatically. The shown data import modules in the ***Import*** menu vary according to the program version. Only the data import modules of your individual ***GART-2000® CE*** version are shown:

Up to now the following formats are supported:

ASCII, Caddy, Card/1, EDBS, GEOgraf, LSA, LVANDS, MAS80/EF800, NRW, Poepping, Praxl, Minka, DAC100, REC500, PTS, CSV, COD, LLH, KOF, DXF, GRIPS, GT

Further formats are in preparation or will be developed on demand.

4.1.10.1 ASCII 3.0

The **ASCII 3.0** format is standard in all versions. With the **ASCII 3.0** format coordinates and measurements can be exchanged between different ***GART-2000®*** program versions (DOS and CE).

After choosing the **ASCII 3.0** format the Windows-standard Open File menu is opened: Choose the directory and the name of the import file.

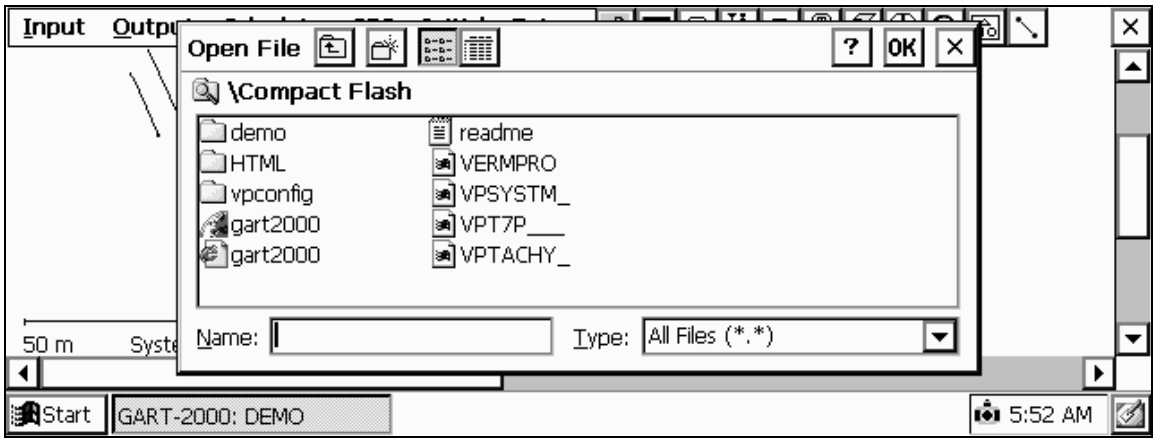


Figure 4-29: Import with ASCII 3.0

All coordinates that are imported from a file or entered manually are nominal values and, therefore, cannot be changed by new measurements. The nominal values can only be changed by the edit function in the output menu.

4.1.10.2 ASCII GB

The **ASCII GB** format is the extended version of **ASCII 3.0** for graphical field books. With the **ASCII GB** format the content of projects can be exchanged within ***GART-2000® CE*** or between different program versions (NT and CE).

4.1.10.3 Free Format

To import an individual coordinate file it is possible to define a free format in the **FREEFORM.DEF** file. This file is located in the **vpconfig** directory.

The format definition is explained with comments directly in the file.

4.1.10.4 Leica GSI

Go to the menu ***Input > Import > Leica GSI*** and the dialog opens to select a file. The default directory is the folder of the current project. The file name in this example is called leica-koordinaten.gsi.

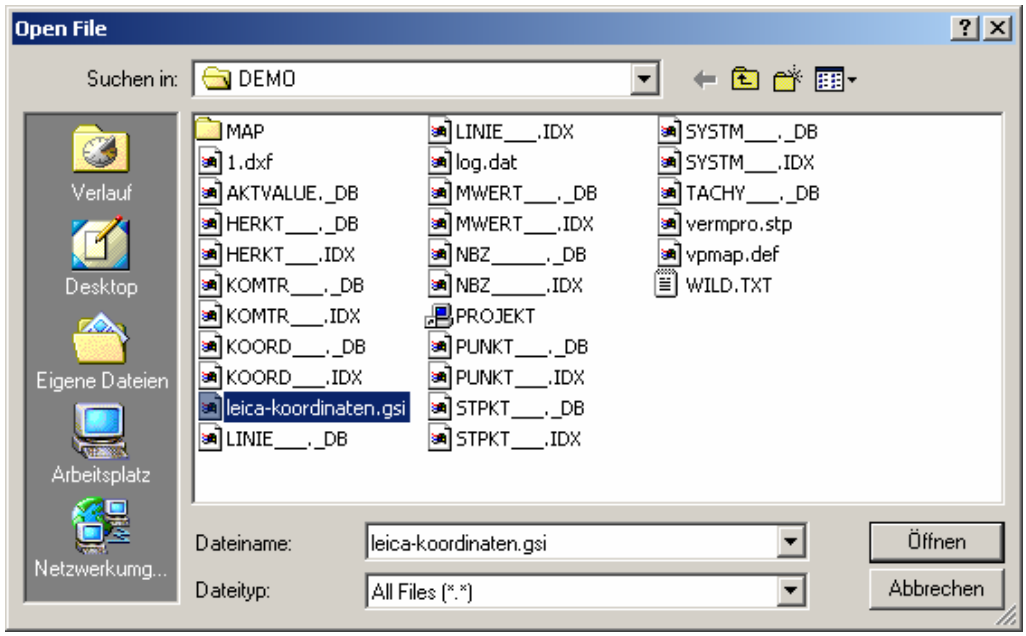


Figure 4-30: Open File

Select the corresponding *.gsi file name and confirm the input with Open. In that way you can import coordinates of the Leica SmartWorx software.

4.1.10.5 COD, CSV, PTS

These formats separate the entries by means of commata (Comma Delimiter). The structure comprises:

- Point number, East, North, height, point code (optional), marker code (optional), comment (optional)
-

4.1.10.6 LLH

The **LLH** format serves the import of geographical coordinates. The structure comprises:

- Point number, latitude, longitude, height, point code (optional), comment (optional)

The imported coordinates refer optionally to the WGS84 System or to the user-system.

4.1.10.7 DXF

Manual for colored DXF input with ***GART-2000®***

Check your layer in DXF-File

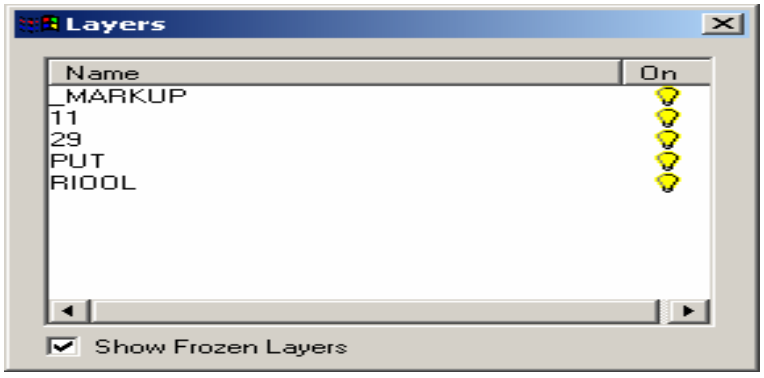


Figure 4-31: Layers

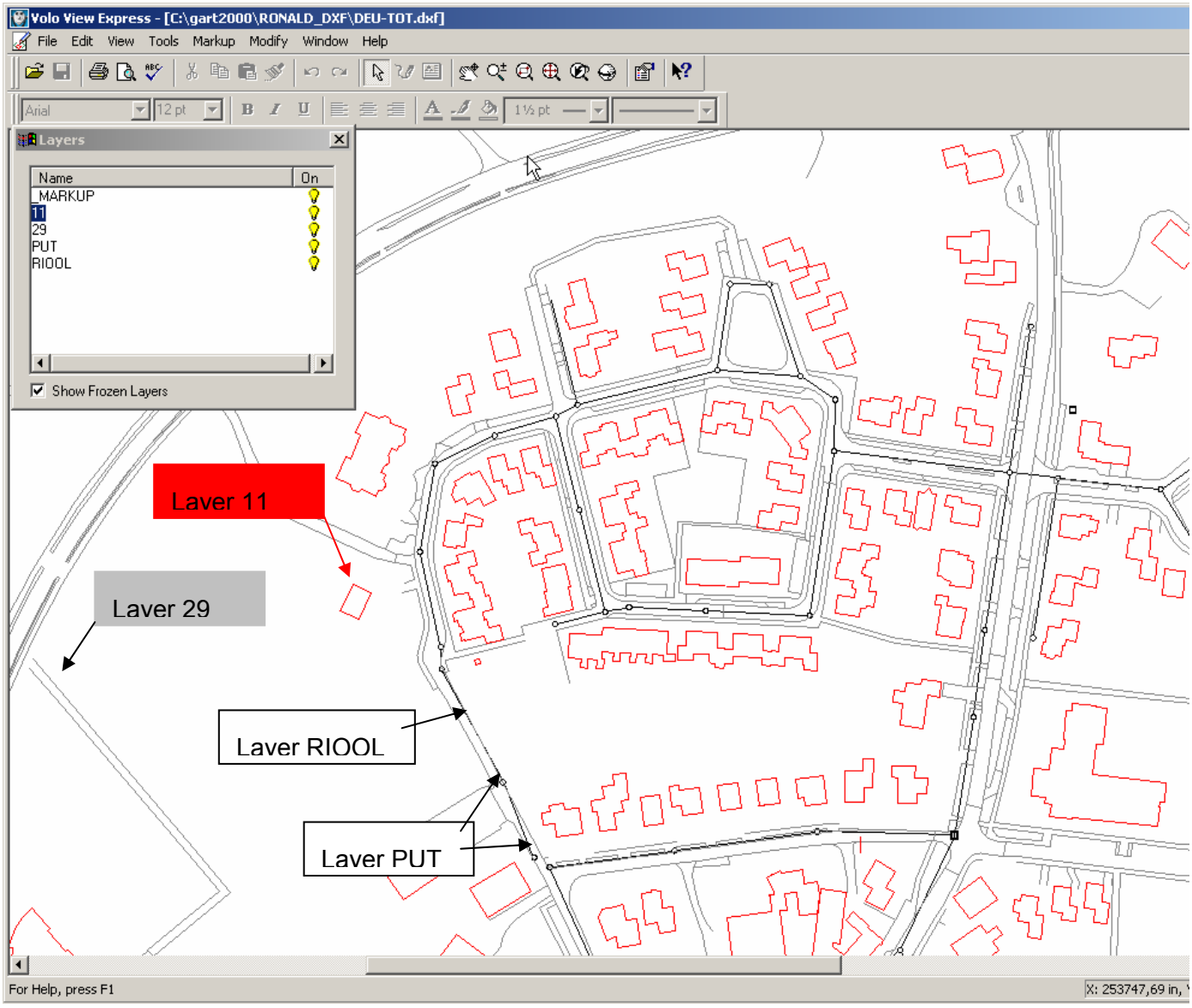


Figure 4-32: Volo View Express

Configure ***GART-2000®*** file **VPCONFIG/DXFSYMB.DEF**

POINTCODE 1

SYMBOL KREIS
LAYER PUT
SCALE 1.0
ANGLE 90.0
ENDPOINTCODE
*
*
* Definitionen fuer Linien
*
LINECODE 1
LAYER **RIOOL**
ENDLINECODE
*
LINECODE 2
LAYER **11**
ENDLINECODE
*
LINECODE 3
LAYER **29**
ENDLINECODE
*

Open ***GART-2000®*** and check colors of Linecode 1-3

Initial=> Display =>Folder Parameters
Click to button EDIT

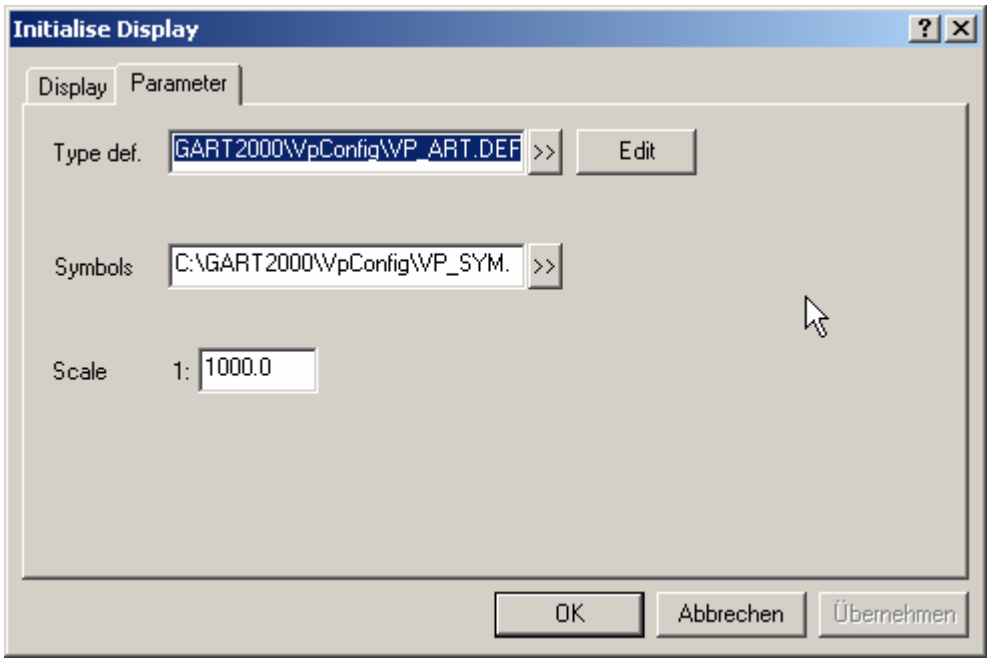


Figure 4-33: Initialise Display

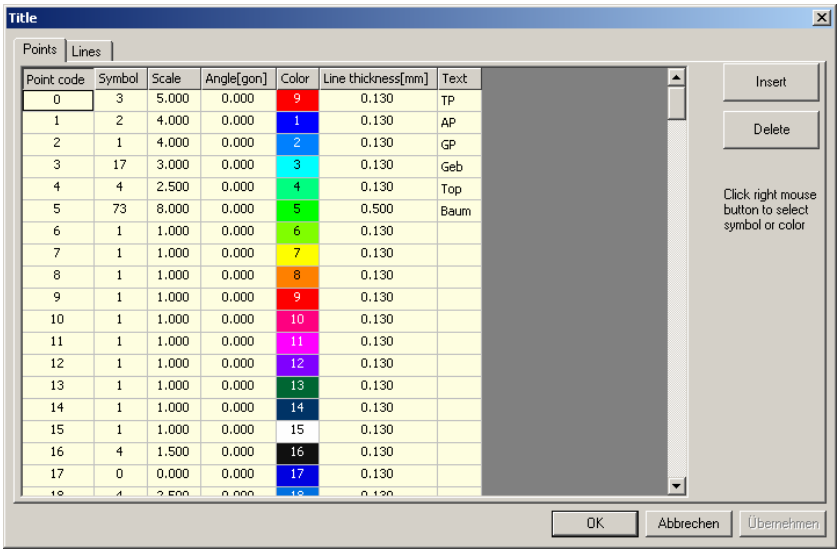


Figure 4-34: Title

Go to layer **LINES** and choose colour

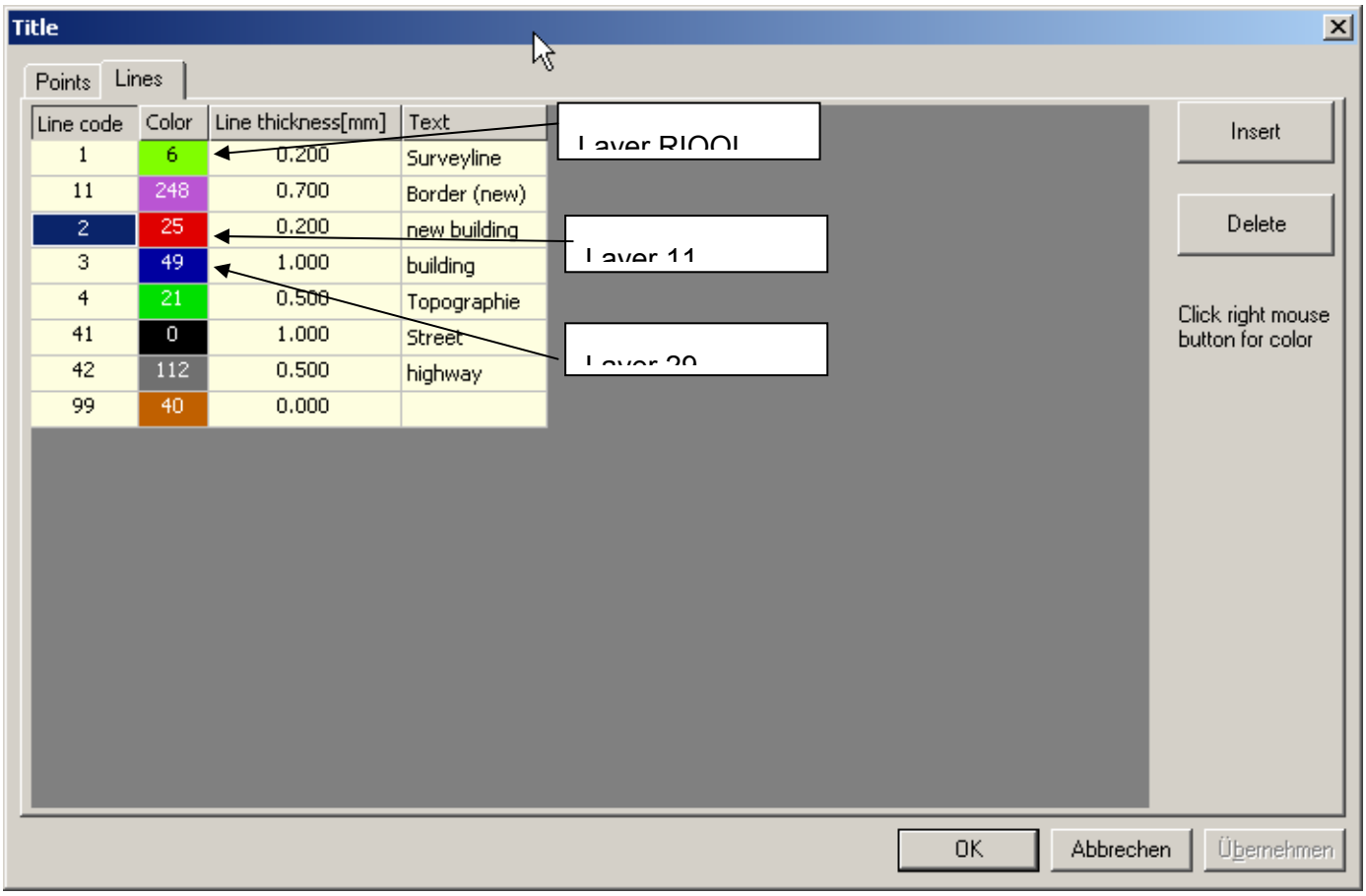


Figure 4-35: Title

Confirm with OK.

Import DXF file through **Input=>import=> DXF**

Choose definition path, do not take default values

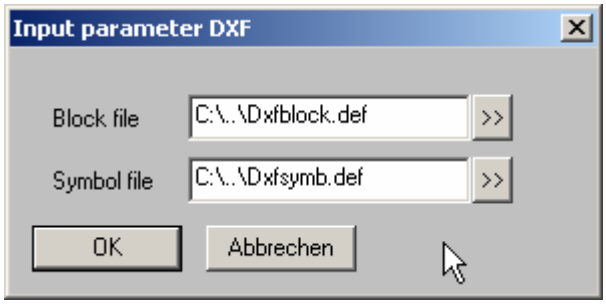


Figure 4-36: Input parameter DXF

Choose import DXF-File

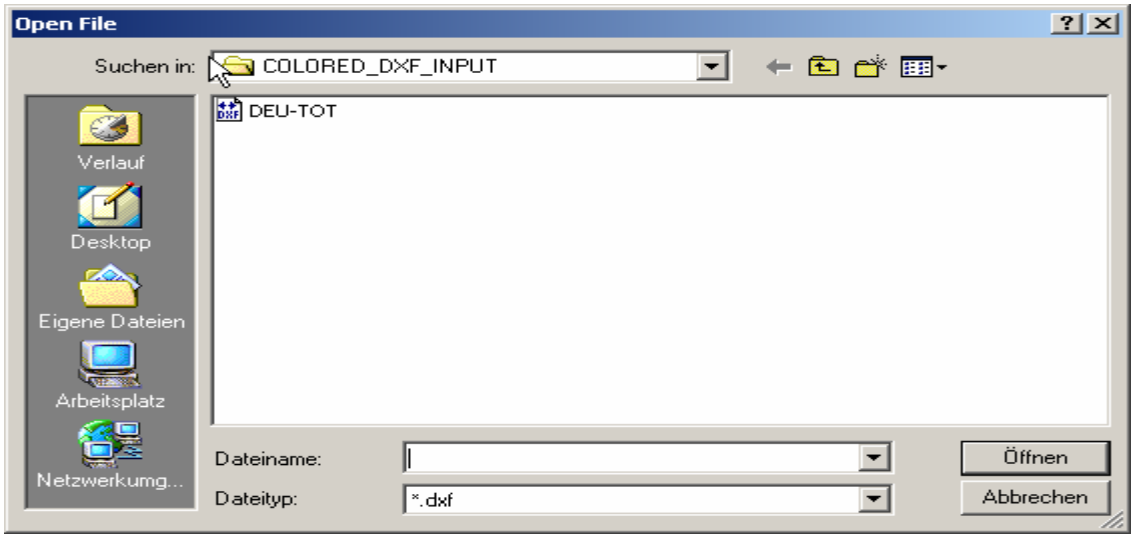


Figure 4-37: Open File

In lower left corner of ***GART-2000®*** windows, you can see status report. Please be patient.

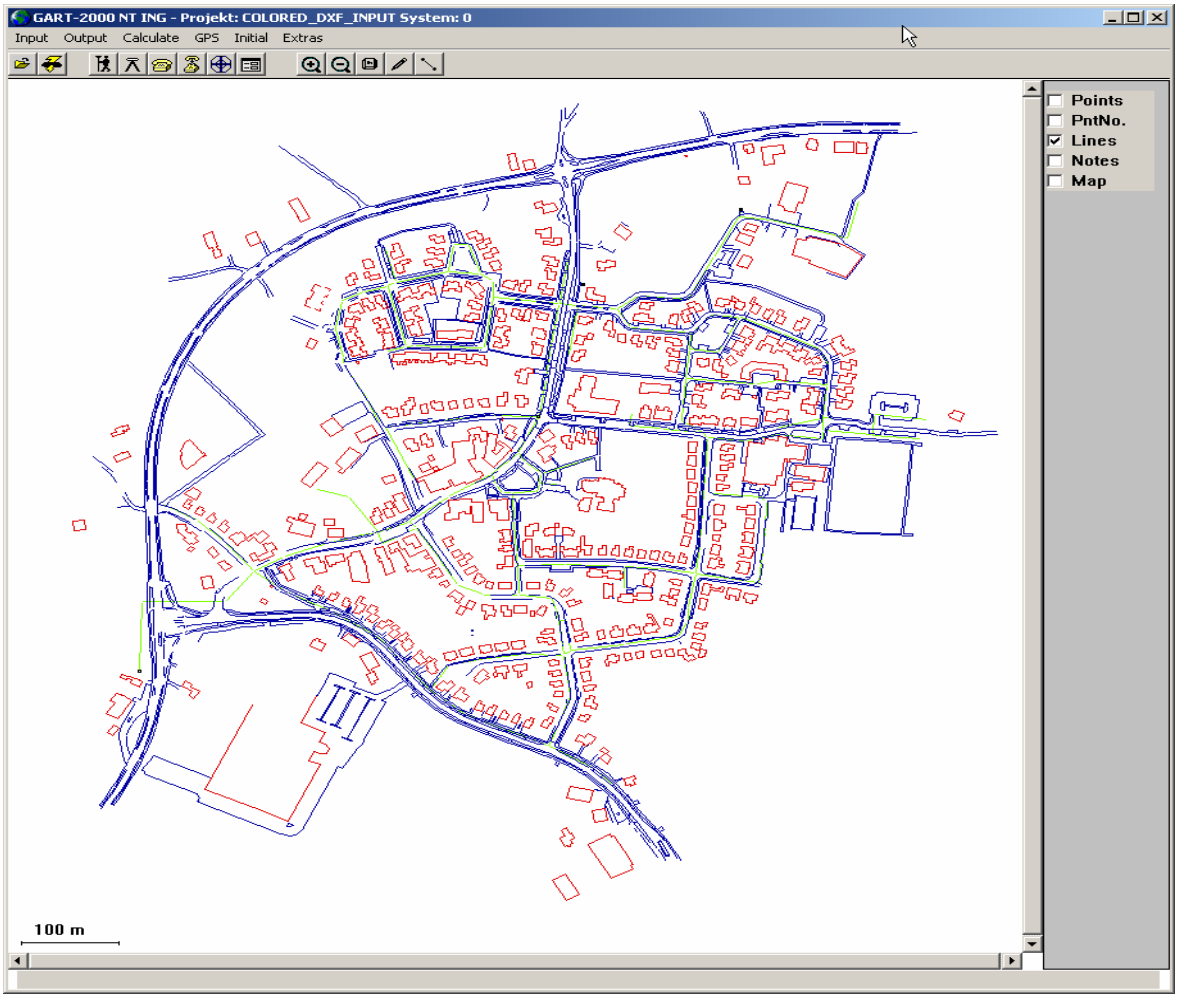


Figure 4-38: COLORED_DXF

Please note, that ***GART-2000®*** will not import splines or curves. Only lines will be imported.

Export DXF with GART2000

The DXF export depends on the point- or line type. It is necessary to configure the two files in the folder VPCONFIG:

DXFBLOCK.DEF

DXFSYMB.DEF

In he file DXFBLOCK.DEF, it is possible to configure the Blocks that will be exported to DXF

Example:

```
* Kommentar
*r=east, h= north, rad=Radius,
*wa=start angle, we=end angle


* Kommentar
* Syntax:
* SYMBOL name
* LAYER  name
* POINT  r h
* LINE   r1 h1 r2 h2
* CIRCLE r h rad
* ARC    r h rad wa we
* ENDSYMB
*
* Mainsymbol CIRCLE
*
SYMBOL CIRCLE
LAYER  CircleLayer
CIRCLE 0.0 0.0 .5
ENDSYMB
*
* Mainsymbol Dreieck
*
```

In he file DXFSYMB.DEF, it is possible to configure the Symbol concerning the pointtyp ord line type

Example:

```
* POINTCODE  PunktPOINTCODE
* SYMBOL Blockname has to be defined in DXFBlock.def
* LAYER  Layer for AutoCAD String has to be less than 30 elements
* SCALE   Scale for symbolintegration in DXF
* ANGLE Angle in DEGREES [0-360]
* ENDPOINTCODE End of definition
*
*Later settings will overwrite the previous ones.
*
TEXT
TEXTLAYER PUNKTNUMMER
TEXTSIZE   0.25
TEXTANGLE  0
TEXTDX     0.40
TEXTDY     0.01
ENDTEXT
*
* Standardlayer for lines if not defined with LINECODE
*
LINES
LINELAYER Linien
ENDLINES
*
* Layer for Notes
*
NOTES
NOTESLAYER Notizen
ENDNOTES
*
* Text for pointheight
*
HEIGHTS
HEIGHTLAYER HOEHE
HEIGHTSIZE  0.25
HEIGHTANGLE 0
HEIGHTDX      0.40
HEIGHTDY     -0.40
ENDHEIGHTS
```

Example with ***GART2000***:

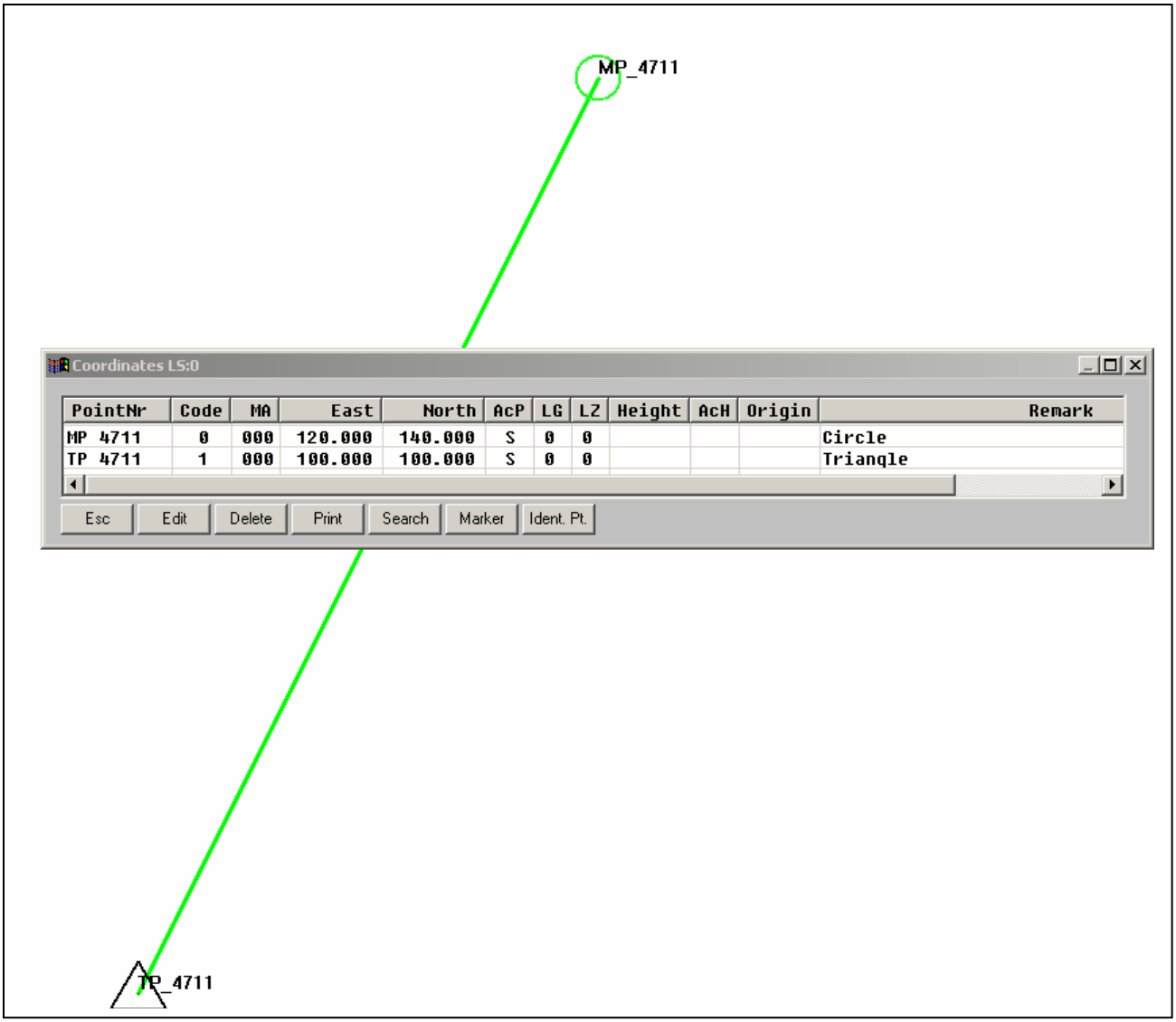


Figure 4-39: Coordinates L5:0

If you choose OUTPUT=> EXPORT=>DXF

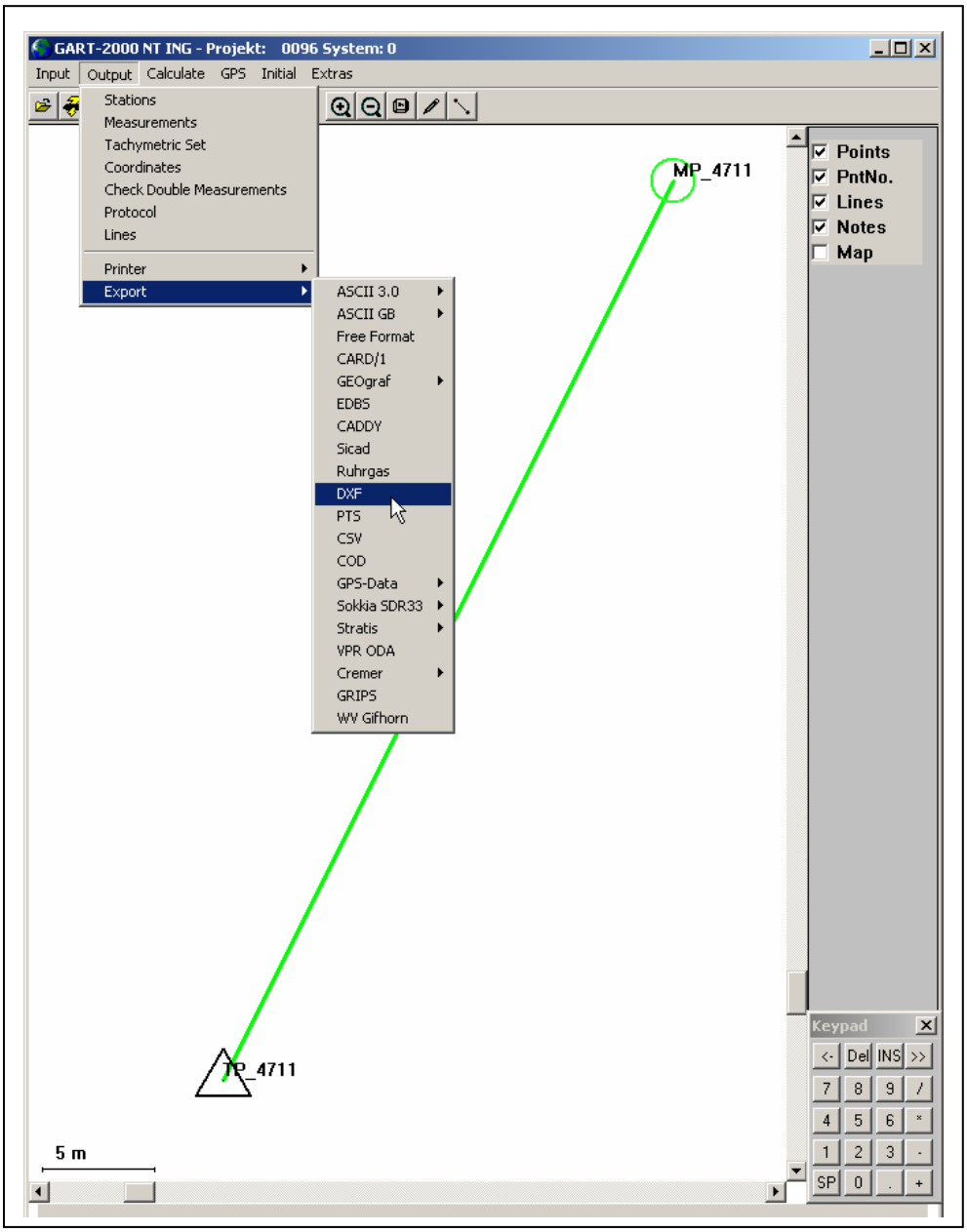


Figure 4-40: Output> Export> DXF

You will get:

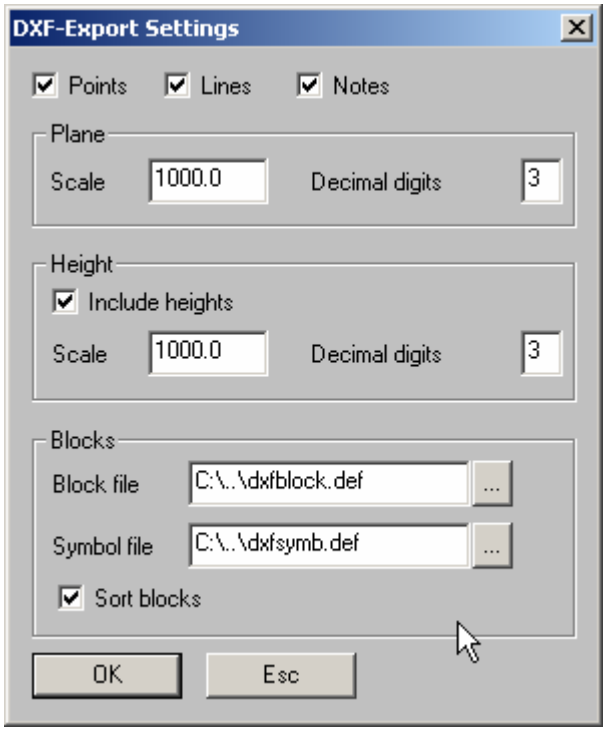


Figure 4-41: DXF-Export Settings

Be sure, that you set the right path for the files dxfblock.def and dxfsymb.def.

Choose your File output name

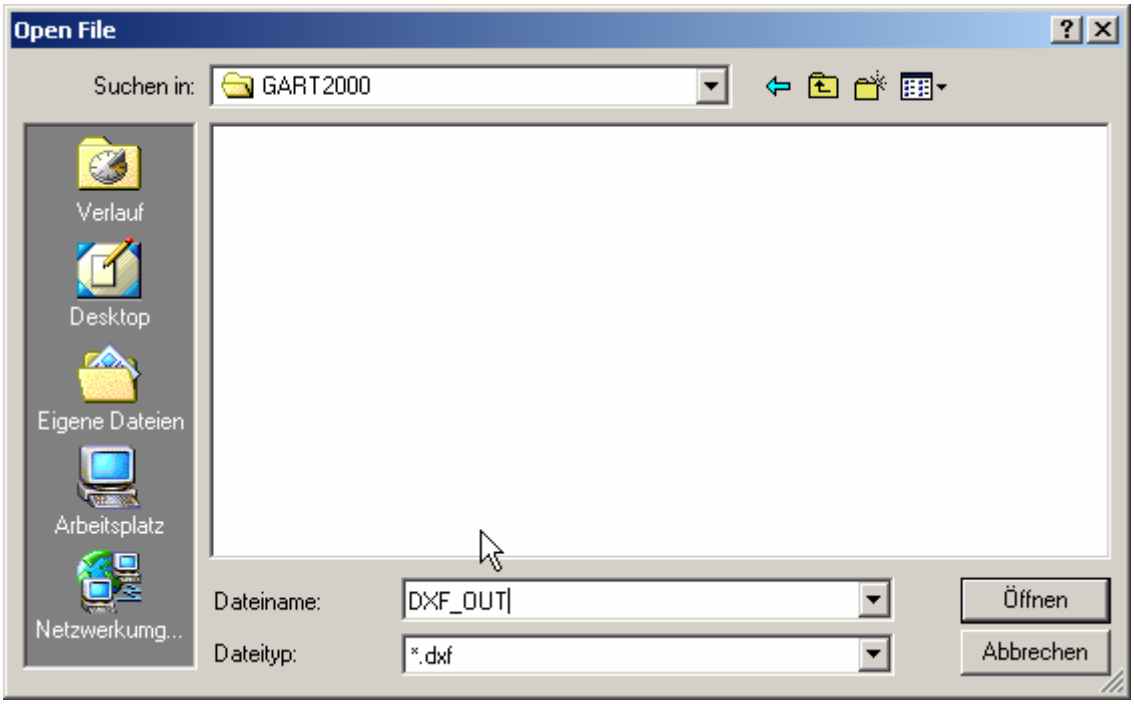
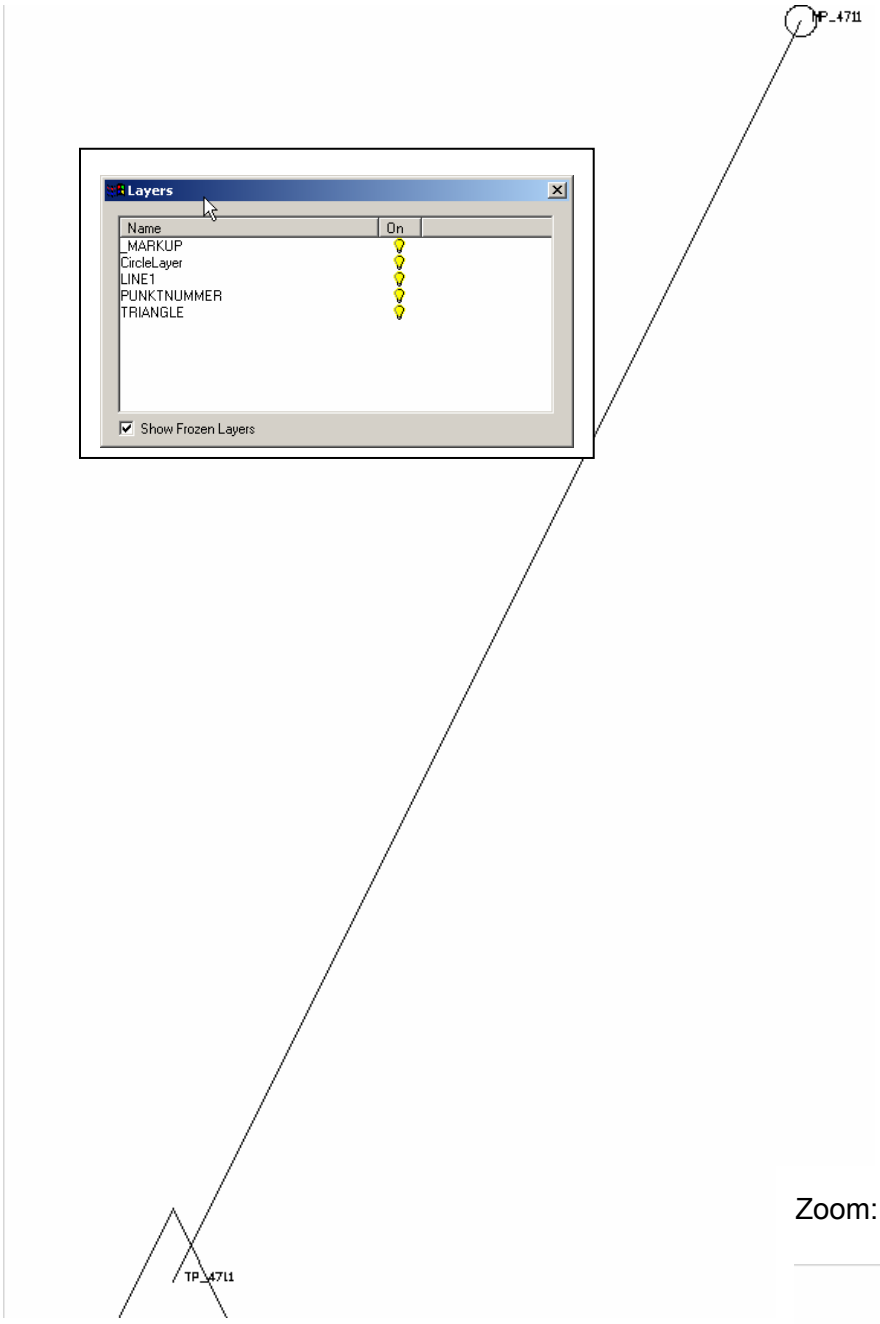


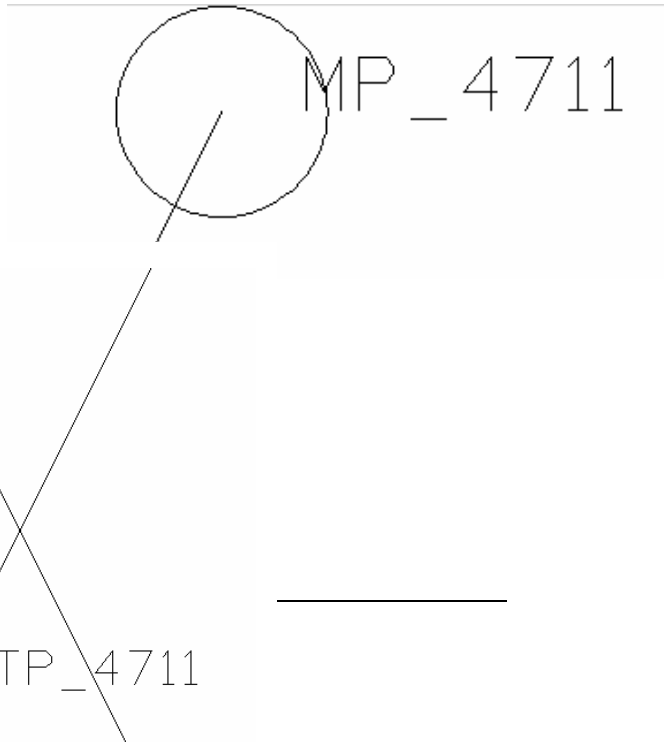
Figure 4-42: Open File

After that, you'll have exported the

Output in VoloView:



Zoom:



4.2 Output

4.2.1 Stations

After choosing the function ***Output > Stations*** a list of all existing stations is displayed:

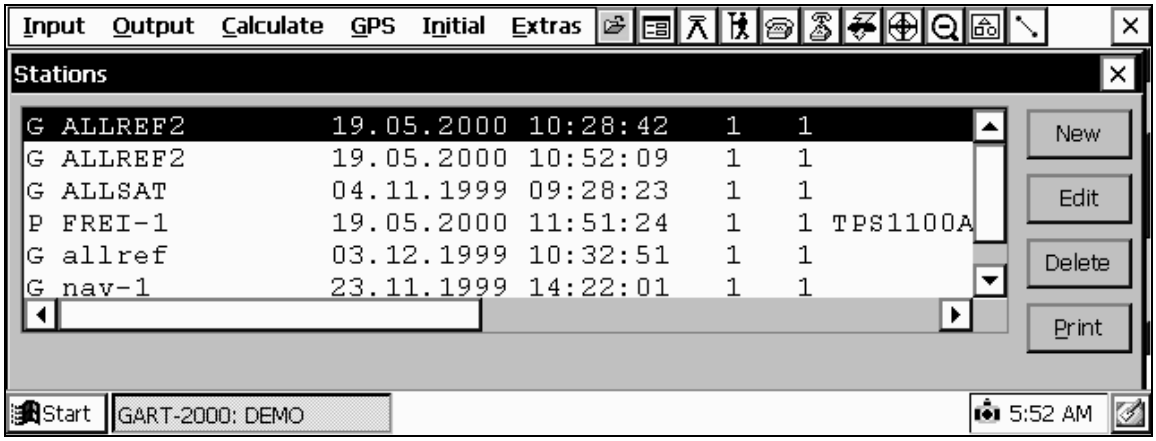


Figure 4-43: Output Stations

For GPS the point where the GPS reference station is initialised or the total station is positioned is called station.

GPS-stations are marked with a ***"G"*** before name and total stations are marked with a **P** and the used instrument.

For every station the date and the time when it was created is displayed. Furthermore, the point code, the marker type and the instrument height are shown. With the Button **<New>** a new station is created. With the Button **<Delete>** the chosen station including all measurements is deleted.

With the button **<Edit>** the station data can be edited. The following entries are shown:

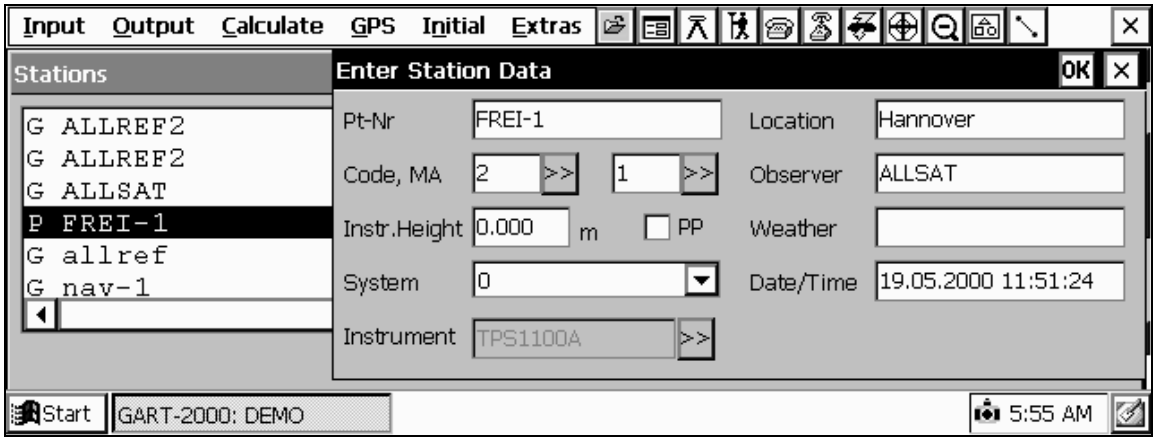


Figure 4-44: Edit Station data Total Station

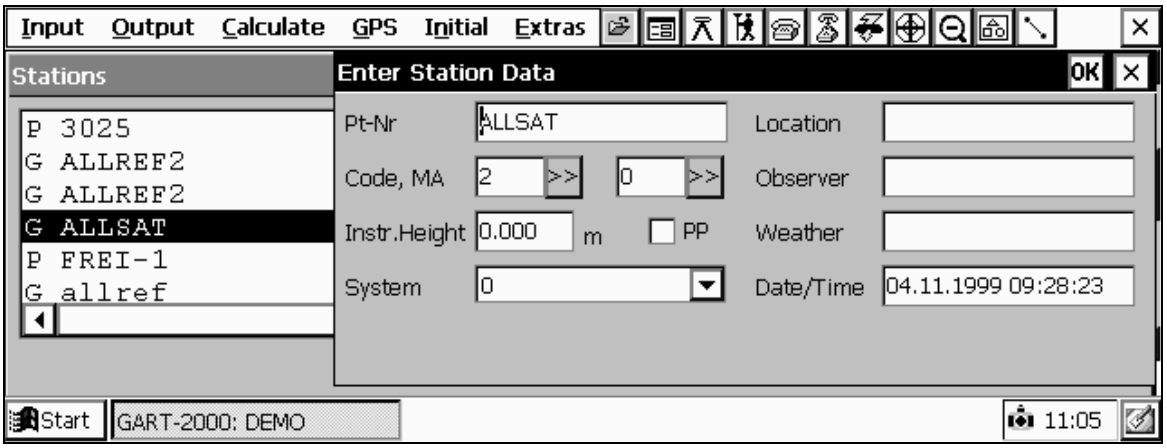


Figure 4-45: Edit Station Data GPS

The fields have the following meanings:

PntNo.	Point number of the station
Code, MA	Point code and marker type of the station
Instr.Height	Instrument height
PP	If the point is used as a control point this box is checked.
System	If different systems are used in a project, the system of the station needs to be selected. All coordinates of measurements that relate to this station are stored in this system.
Date/Time	Date and time of the station creation

Location, Observer and Weather are additional information, which is useful for the documentation of a project.

4.2.2 Measurements

Measurements are always stored related to the station in ***GART-2000® CE***. with ***Output > Measurements*** the GPS measurements that were recorded on the chosen station are listed:

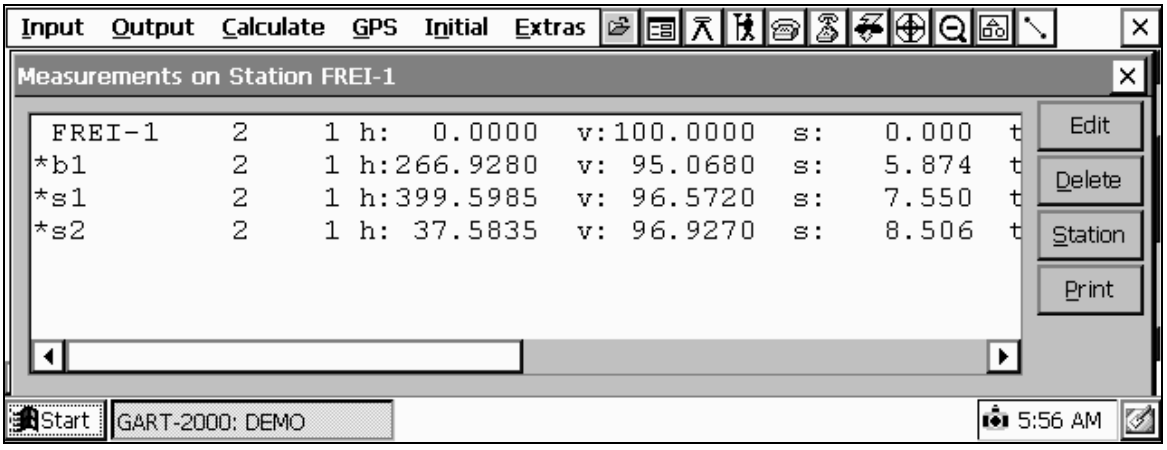

Input Output Calculate GPS Initial Extras
Measurements on Station FREI-1
FREI-1 2 1 h: 0.0000 v:100.0000 s: 0.000 t
*b1 2 1 h:266.9280 v: 95.0680 s: 5.874 t
*s1 2 1 h:399.5985 v: 96.5720 s: 7.550 t
*s2 2 1 h: 37.5835 v: 96.9270 s: 8.506 t
Edit
Delete
Station
Print
Start
GART-2000: DEMO
5:56 AM

Figure 4-46: Output Measurements Total Station

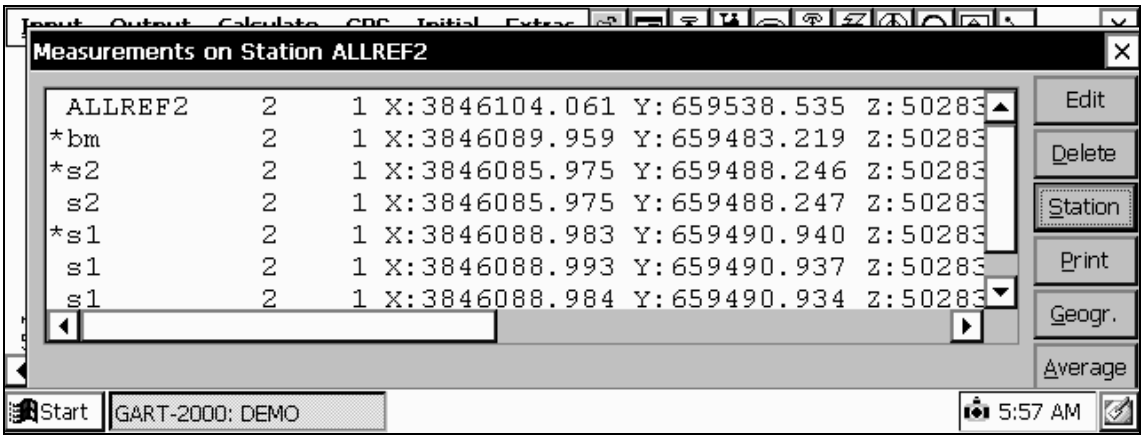


Figure 4-47: Output Measurements GPS

In the first row the station measurement is listed. Afterwards all GPS measurements are listed in chronological order.

The total station measurements are displayed with point number, point code, marker type, horizontal and vertical direction, and slope distance. The target height and, where applicable, the ex-centers of the target point are also given.

In addition to point number, point code, marker type and geocentric coordinate, in the case of GPS measurement values the standard deviations, antenna height, number of satellites, PDOP and fixing mode are also displayed. Any comment that has been entered follows at the end of the line.

By means of the button **<Edit>,** the measurement values that have been marked can be edited. **<Delete>** removes the marked values. The **<Station>** button enables the user to switch between the different stations of the project. With the **<Print>** button, the measured values can be written to a file in formatted form or sent to a printer. The relevant presettings can be selected under the menu item ***Initial > Protocol***.

Two additional options are available for the output of GPS measurements. By selecting the button **<Geogr.>**, you can change the representation of the GPS measurements from Cartesian to geographical. The button **<Average>** effects the averaging of measurement values with the same designation. As a result of this process, the averaged values are deactivated and marked with a ´#´. The mean ascertained is inserted in the form of a new measurement value at the end of the list.

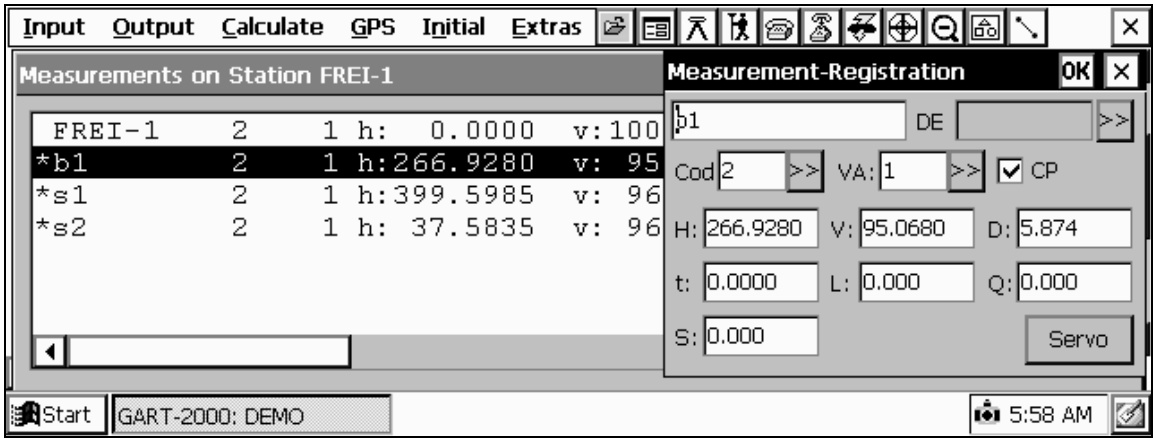


Figure 4-48: Edit Measurements Total Station

The following data can be edited:

	Point number (here: ***b1***)
Cod	Point code
VA	Marker type
CP	To define this point as a control point, activate the **CtrlPnt** checkbox.
H	Horizontal angle
V	Vertical angle
D	Slope distance
T	Target height
L	Longitudinal ex-center
Q	Transverse ex-center
S	Distance ex-center

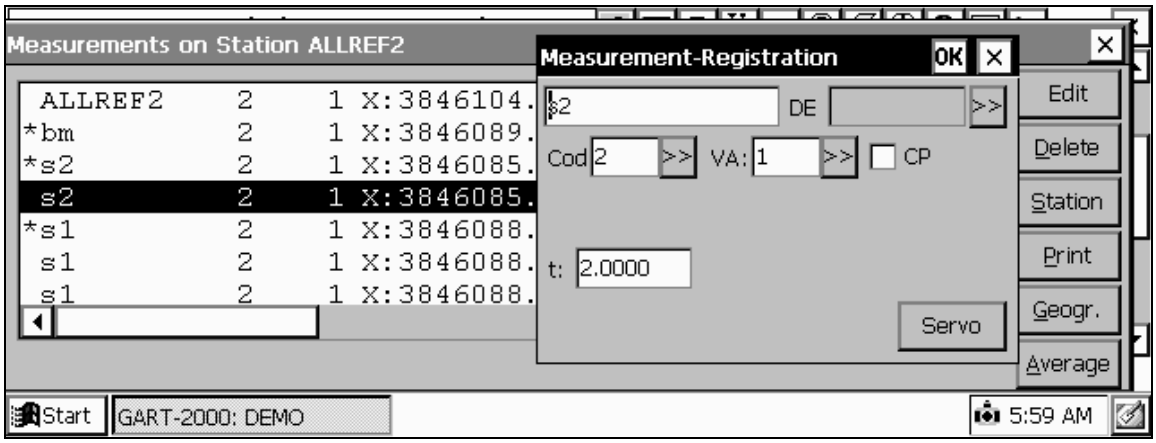


Figure 4-49: Edit Measurements GPS

The following data are shown:

Point number (here: ***s2***)

Code Point code

VA Marker type

T Antenna height

CP To define this point as a control point, activate the **<CP>** checkbox

The button **<Geogr.>** transforms the geocentric WGS84 coordinates (X,Y,Z) into geographic WGS84 coordinates (longitude, latitude, ellipsoidal height).

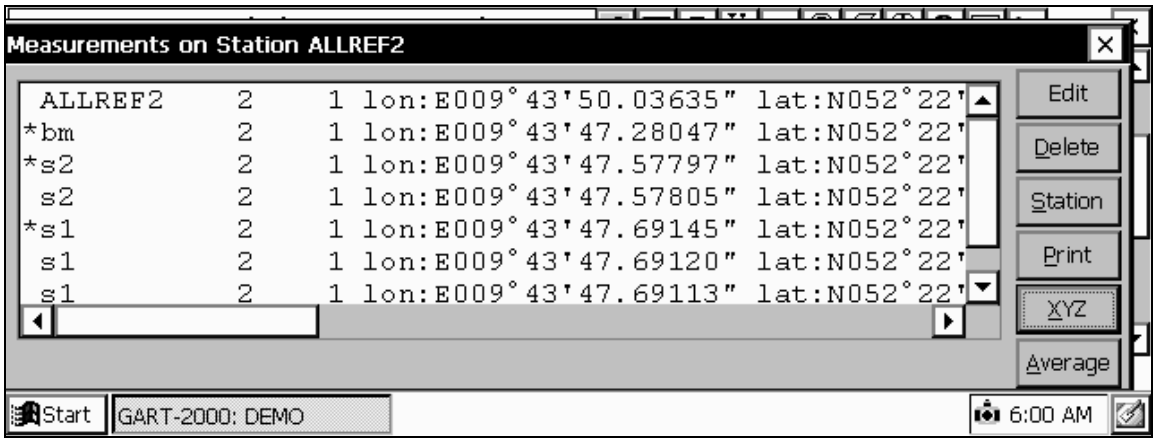


Figure 4-50: Output Measurements in geographical form

To average multiple measurements, mark the corresponding point number and click on the button **<Average>**. ***GART-2000® CE*** displays the differences of the averaged measurements and adds the averaged value at the end of the list.

4.2.3 Tachymetric Set

By means of the menu function ***Output > Tachymetric Set*** the tachymetric set can be displayed and modified. The following window appears:

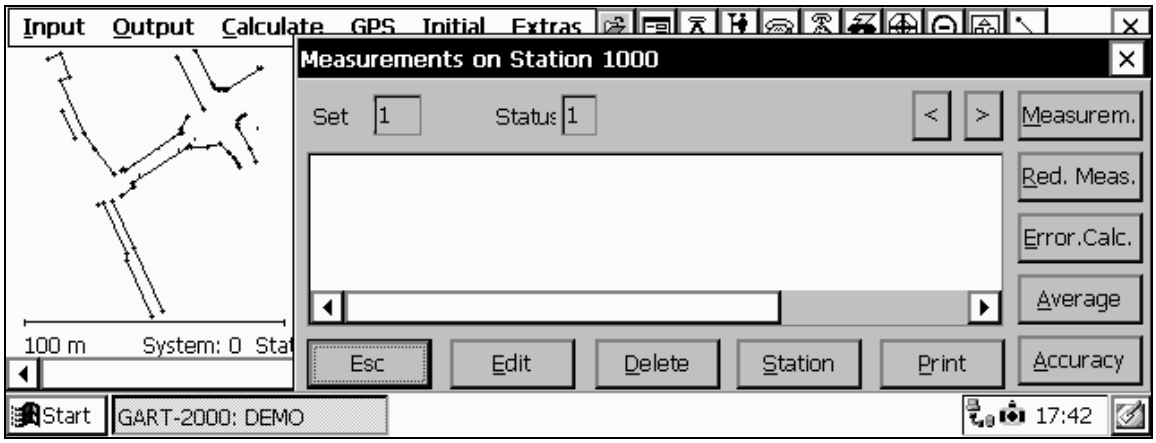


Figure 4-51: Overview of measurements in a tachymetric set

The measurements can be displayed and modified through various buttons:

<Measurem.>	Clicking this button displays the measured values directly. Using the "**<**" and "**>**" keys, you can switch between the 1st and 2nd faces and between the sets.
<Red. Meas.>	This button activates the display of the reduced directions distinguished according to Face 1 and Face 2.
<ErrorCalc.>	In the error calculation, the following display is shown for each target point: **d**: Difference between the set mean of the distances towards a target and the total mean value from all sets. **v**: Improvement of the direction of the respective set **vz**: Improvement of the zenith distance **vp**: Improvement of the vertical index **vs1**, **vs2**: Improvement of the distances in Face 1 and Face 2 (only for overall

	measurement)
<Average>	This button activates the averaging of the reduced directions of Faces 1 and 2.
<Accuracy>	Clicking this button opens a further window containing an overview of different accuracies. These comprise: **Sr**: Standard deviation of a direction measurement **Srm**: Standard deviation of the mean of the direction measurements **Phi**: Vertical index error **Sz**: Standard deviation of the zenith angle **Szm**: Standard deviation of the mean of the zenith angle **Sp**: Standard deviation of the vertical index error of a set **Spm**: Standard deviation of the mean of the vertical index errors of all sets **Ss**: Standard deviation of a distance measurement
<Print>	This button logs the tachymetric set in the protocol file.
<Station>	Clicking this button calls up the window to change the station.
<Delete>	This button is only active when the measurement values are displayed. All measurements for the current set are deleted in each case.
<Edit>	This function allows the modification of individual measurement values and all their associated data.
<Esc>	This function serves to quit the display dialog.

4.2.4 Coordinates

With the menu ***Output > Coordinates*** all coordinates of the actual system are listed:

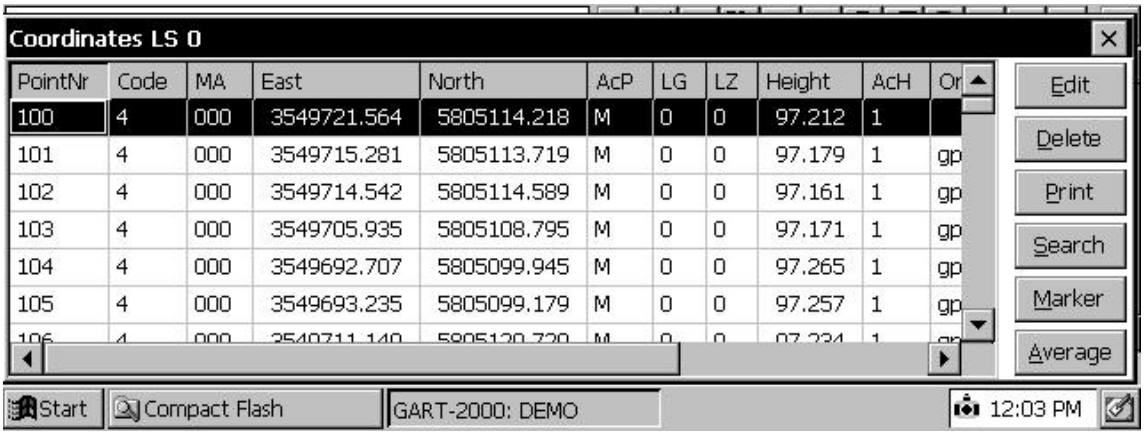


Figure 4-52: Output Coordinates

The figure contains all coordinates of a project in the chosen system. A click on a point in the graphic screen marks the actual coordinate in the list.

The coordinate information includes point number, point code, marker type, east, north, position precision, height, height precision, station information and comments.

With **<Print>** the measurements can be inserted into a file (see 4.5.8). To delete a coordinate, mark it and press the button **<Delete>**.

To search for a certain point press **<Search>** and enter the point number or click on the point in the graphic screen. The list scrolls automatically to the individual point.

To edit points, i.e. to change point code, point number, coordinates, system, precision or to enter a comment press **<Edit>** or double click on the coordinate.

Press the button **<Marker>** and enter the point number, point code, marker type, easting, northing, height, accuracy level of the position and height and a commentary.

Those points, which were selected by the Space-Key or by the function **<Marker>**, can be averaged after pressing the button **<Average>**. They will be stored as debit plane coordinates. If coordinates are marked, which have different point numbers, just the marked coordinates of the first point will be taken over into the dialog “Average coordinates”.

Press the button **<Pan>** to center the graphic screen on a selected point. This point can be selected in the graphic screen or in the coordinate output list (supported only in ***GART-2000® NT / Viewer***).

Activate **<Zoom>** to zoom on a selected point (supported only in ***GART-2000® NT / Viewer***).

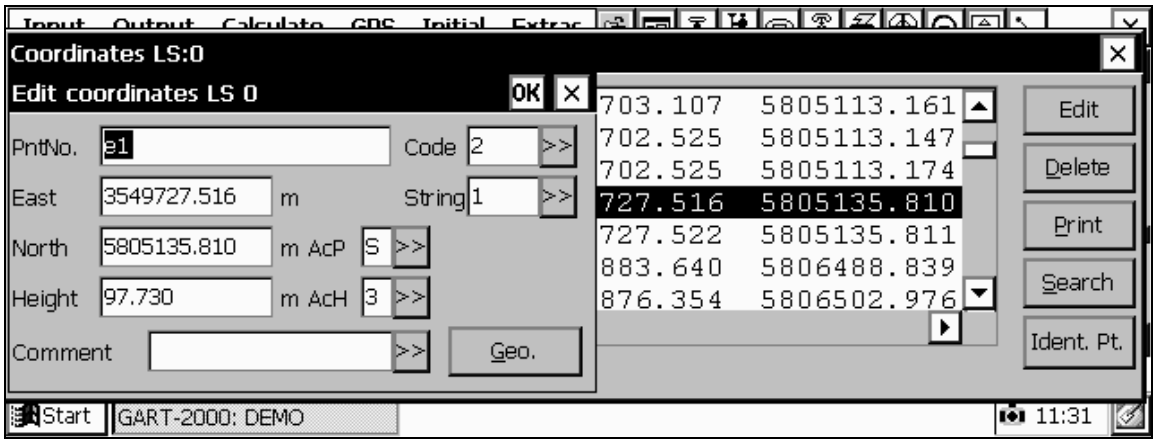


Figure 4-53: Edit Coordinates

The fields have the following significance:

PntNo.	Point number with up to 32 alphanumeric characters
Code	Point code
String	Marker type
East	Easting in the user coordinate system [m]
North	Northing in the user coordinate system [m]
Height	Height in the user coordinate system [m]
AcP	Accuracy of the position: 0 - No position D - Digitalized point M - Measured point R - Calculated point S - Control point
AcH	Accuracy of the height: 0 - No height 1 - Level 1 (lowest level, e.g. total station) 2 - Level 2 (intermediate level) 3 - Level 3 (highest level, e.g. height control point)
Origin	Origin concerning a station with following statements:

	-Station information -Date -Time
Remark	Commentary to enhance documentation of the project

The coordinates can be entered either in plane or, using the button **<Geo.>,** geographical mode. A conversion between user-coordinates and geographical mode is done automatically when switching between the modes.

The Button **<Geo.>** switches from plane coordinates to geographical coordinates for the conversion, the current user coordinate system specified under ***Initial > Constants > GPS*** are used.

4.2.5 Check Double Measurements

With the menu ***Output > Check Double Measurements*** a dialog is shown, in which all measured data are listed together with their position and a comment. With this overview it is possible to check both which points are measured several times and from which position you have measured the points.

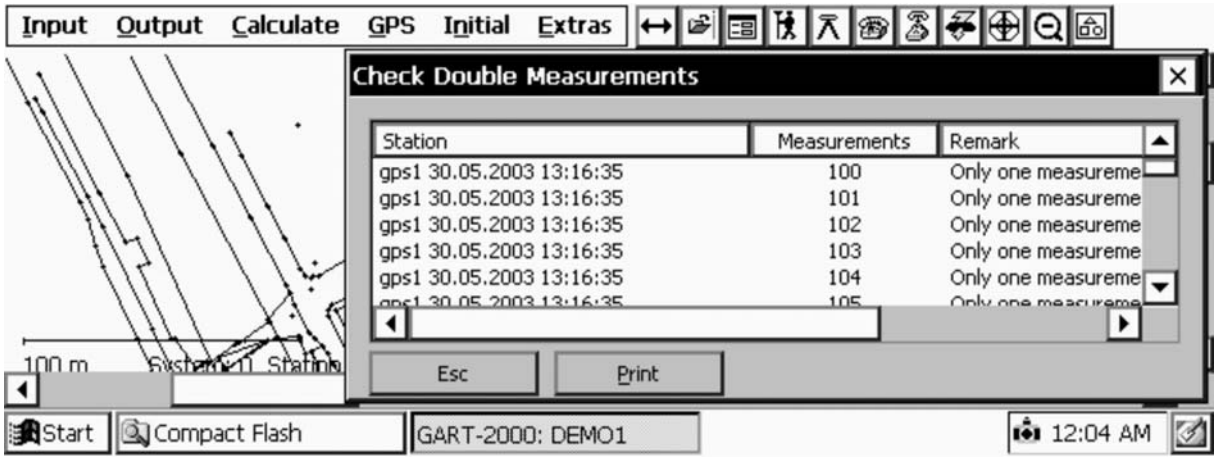


Figure 4-54: Input Check Double Measurement

4.2.6 Protocol

With the menu ***Output > Protocol*** the protocol output file will be opened using the standard editor.

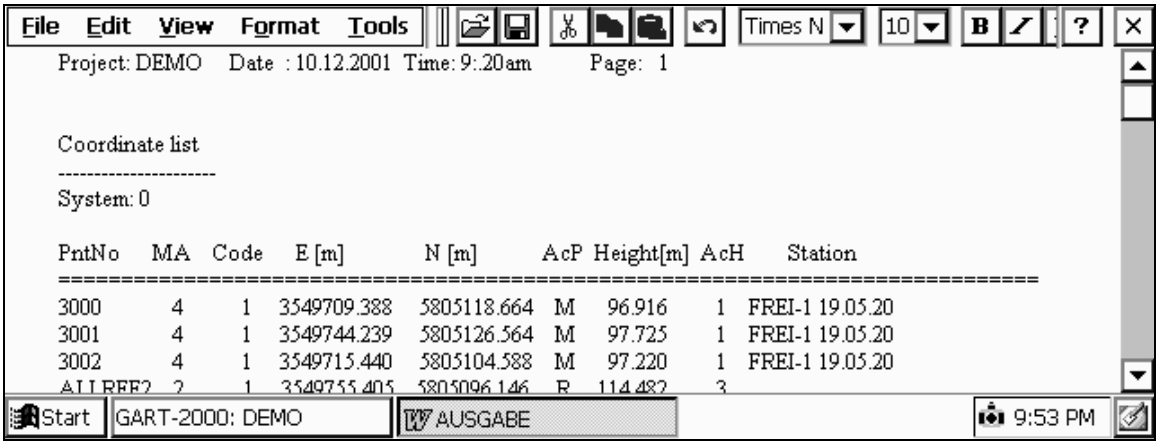

File Edit View Format Tools
Times N
10
Project: DEMO Date : 10.12.2001 Time: 9:.20am Page: 1
Coordinate list
System: 0
PntNo MA Code E [m] N [m] AcP Height[m] AcH Station
3000 4 1 3549709.388 5805118.664 M 96.916 1 FREI-1 19.05.20
3001 4 1 3549744.239 5805126.564 M 97.725 1 FREI-1 19.05.20
3002 4 1 3549715.440 5805104.588 M 97.220 1 FREI-1 19.05.20
Start
GART-2000: DEMO
AUSGABE
9:53 PM

Figure 4-55: Output protocol

The figure shows the coordinate protocol opened with Microsoft® Pocket Word. For the definition of the protocol output see 4.5.8.

4.2.7 Lines

To see all lines of the actual project activate the menu ***Output > Lines.*** Point number, point code and marker type of the start and end point, as well as the length and the difference in elevation are given.

You can select a line both in the list and in the graphical screen. If the line is picked in the list, it will be highlighted in the graphical screen and vice versa.

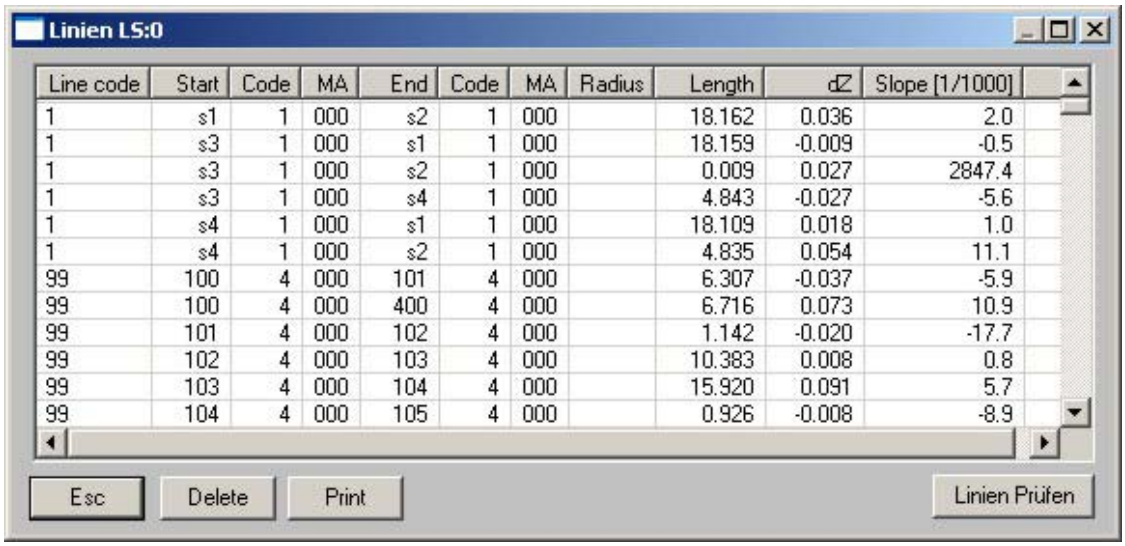


Figure 4-56: Output Lines

To delete selected lines, press the button **<Delete>**, to print the overview of all lines, press the button **<Print>**.

It is possible to check if the start or end point of a line is missing by pressing the button **<Linien Prüfen>.**

4.2.8 Export

With the menu ***Output > Export*** data can be exported with respect to the format specifications of other programs. The shown data export modules in the menu ***Export*** vary according to the program version. Only the data export modules of your individual ***GART-2000® CE*** version are shown:

Up to now the following formats are supported:

ASCII, CADDY, Card/1, EDBS, GEOgraf, LSA, LVANDS, MAS80/EF800, NRW, Poepping, Praxl, Minka, DAC100, REC500, PTS, CSV, COD, LLH, KOF, DXF, GRIPS, GT, ASO-Format, Freies Format, GRIPS, Ruhrgas, Sicad, VPR_ODA, WGS84

Further formats are in preparation or will be developed on demand.

4.2.8.1 ASCII 3.0

The **ASCII 3.0** format is standard in all versions. With the **ASCII 3.0** format coordinates and measurements can be exchanged between different ***GART-2000***® program versions (DOS and CE).

After choosing the **ASCII 3.0** format the Windows-standard Open File menu is opened: Choose the directory and the name of the import file.

The **ASCII 3.0** export module offers the following options:

- ***All Coordinates:*** for multiple measured points all coordinates are exported
- ***Mean Coordinates:*** for multiple measured points the averaged coordinates are exported
- ***Measurements:*** all measurement are exported
- ***Measurements and Coordinates:*** all measurements and coordinates are exported

It is possible to define the point number range to be exported. The default value is to export all coordinates of the actual system.

After choosing the **ASCII 3.0** format the Windows-standard Open File menu is opened: Choose the directory and the name of the export file.

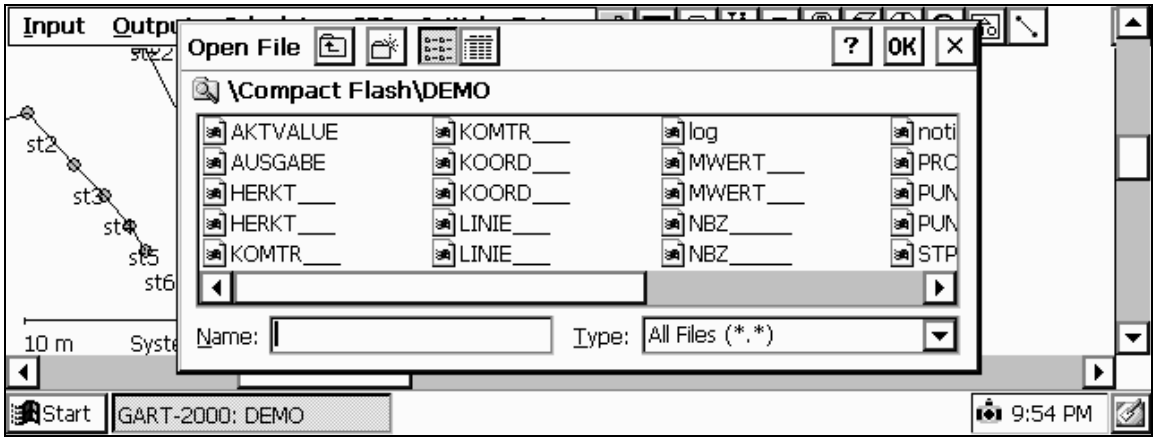


Figure 4-57: Open File

After exporting the number of coordinates is shown.

4.2.8.2 ASCII GB

The **ASCII GB** format is the extended version of **ASCII 3.0** for graphical field books. With the **ASCII GB** format the content of projects can be exchanged within ***GART-2000® CE*** or between different program versions (NT and CE).

4.2.8.3 Free Format

To import an individual coordinate file it is possible to define a free format in the **FREEFORM.DEF** file. This file is located in the **vpconfig** directory.

The format definition is explained with comments directly in the file.

When choosing **Free format** the Open File dialog first asks for the location of the **FREEFORM.DEF** file and after that for the name of the export file.

4.2.8.4 Leica GSI

Open the project from which the coordinates should be exported into the Leica SmartWorx software.

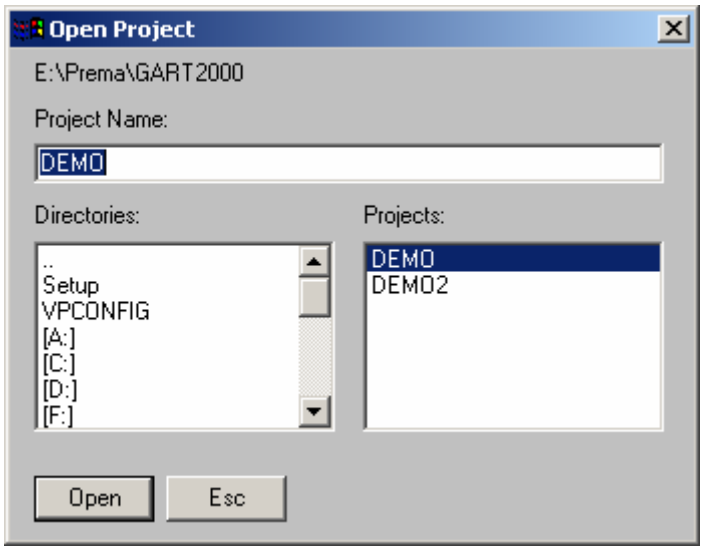


Figure 4-58: Open Project

Choose the menu ***Output > Export > Leica GSI > Coordinates (GSI16)*** and the following dialog opens to save a file.

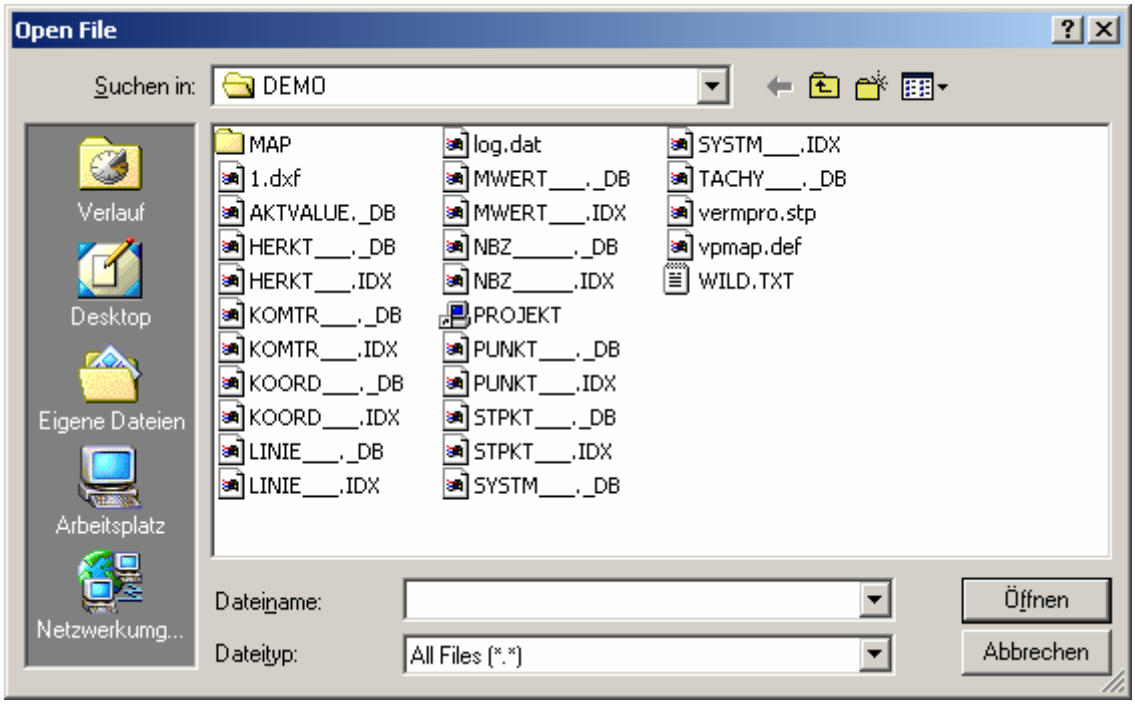


Figure 4-59: Open File

The default directory is the folder of the current project. It is also possible to save the new file in another folder. The file name must have the ending *".gsi"*. In this example the file is called *leica-coordinates.gsi*.

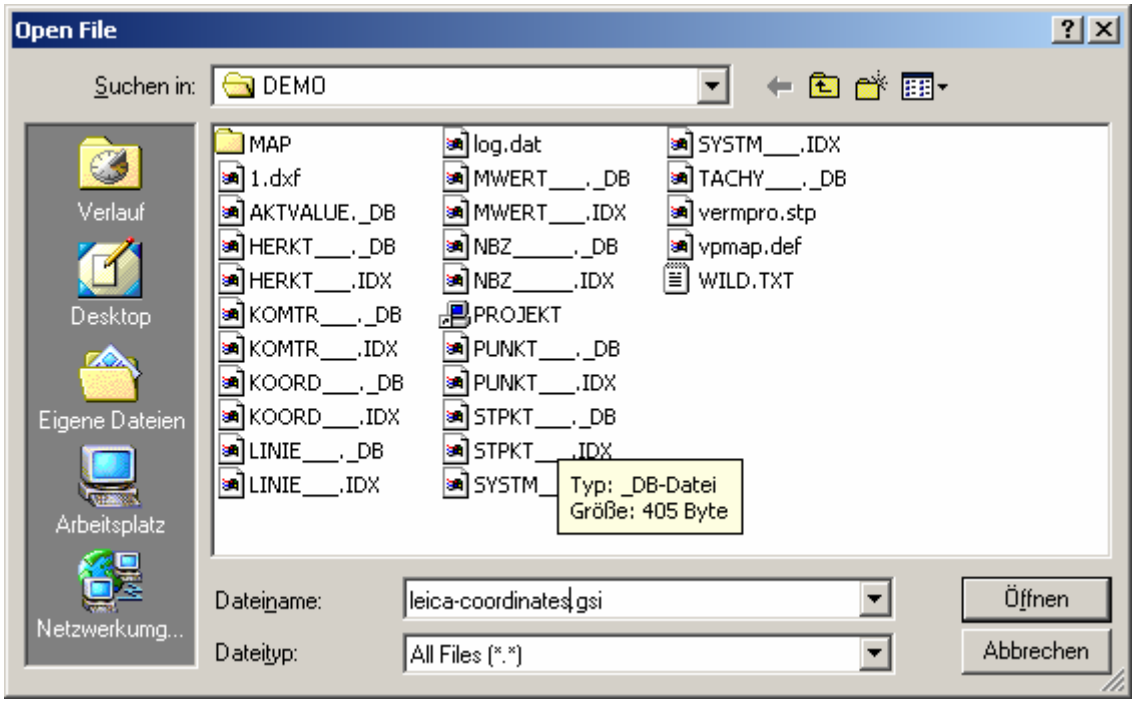


Figure 4-60: Open File

Confirm the input by pressing the **<Open>** button.

Using the following dialog the measurement range can be selected.

Click the buttin **<Öffnen>** for the input the points. With the following dialog the measurement range can be selected.

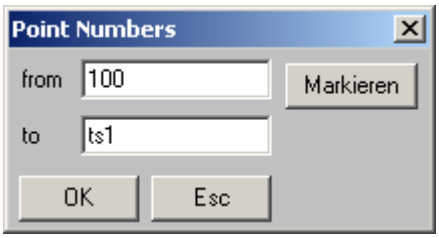


Figure 4-61: Point Numbers

If you do not like to export all points, it is possible to press **<Mark>** in the previous dialog.

After that, a new dialog opens containing all measurements which can be selected accordingly.

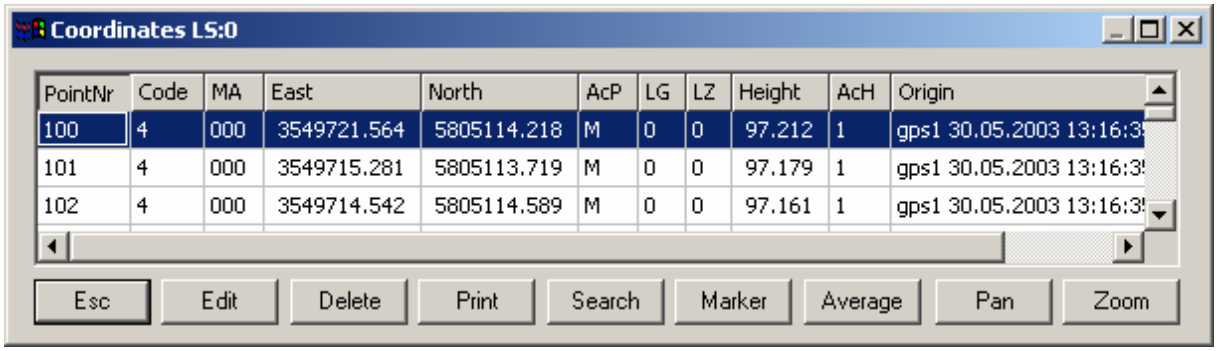


Figure 4-62: Coordinates LS:0

If all values should be exported, the button **<OK>** must be pressed in the previous dialog "Point Numbers". If the export was successful a confirmation message appears.

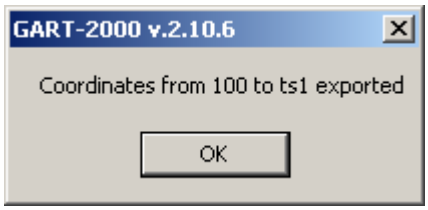


Figure 4-63: ***GART-2000*** *v.210.6*

All coordinates are exported into the Leica GSI format if the user confirms the export by pressing the **<OK>** button.

4.2.8.5 DXF

See 4.1.10.7

4.2.8.6 COD CSV, PTS

These formats separate the entries by means of commata (Comma Delimiter). The structure comprises:

- Point number, East, North, height, point code (optional), marker code (optional), comment (optional)

4.2.8.7 GPS-data

- ***LLH coordinates*** (WGS84): The LLH format is used for the import of geographical coordinates. The format consists of: Point number, latitude, longitudel, height, point type (optional), comment (optional).
- ***LLH coordinates*** (user-system): The imported coordinates refer either to the WGS84-system or to the selected user system depending on choice.
- ***GPS-Measurements*** (all stations)
- ***GPS-Measurements*** (current stations)
- ***UTM-Coordinates*** (zone32)

4.2.8.8. KML (Google Earth)

With this menu point “KML (Google Earth)” you can export your measured coordinates in the KML-Format. KML (Keyhole Markup Language) is a file format for modelling and saving

Geographical elements like points, lines, pictures, polygons and models for the display in Google Earth and Google Maps. With the help of the KML you can exchange the information with other Google Earth- and Google Maps-users.

KML-file is processed by Google Earth and Google Maps in a similar manner like HTML-files and XML-files by a browser. Like HTML, KML has a structure with name and attribute for special representations.

4.2.9 Printer (only supported in Gart-2000® NT / Viewer)

With the menu ***Output > Printer*** an overview of the map can be printed out.

There are two different possibilities:

4.2.9.1 Sheets

Before you can select this submenu, you should define a sheet by using the menu **Initial > Sheet definition**. To do this you have to zoom into a specific region, press the button **New** and give a name for this selected region.

With the menu ***Output > Printer > Sheets*** it is possible to print out the defined sheet.

4.2.9.2 Hardcopy

By activating the menu ***Output > Printer > Hardcopy*** the graphical screen can be printed out.

4.2.10 Google Earth

Google Earth is software which available free of charge form Google inc. for the representation of a virtual globe. It can overlay satellite and aerial pictures of different resolution with geographical data and model them on a digital terrain model of the earth for 3D display.

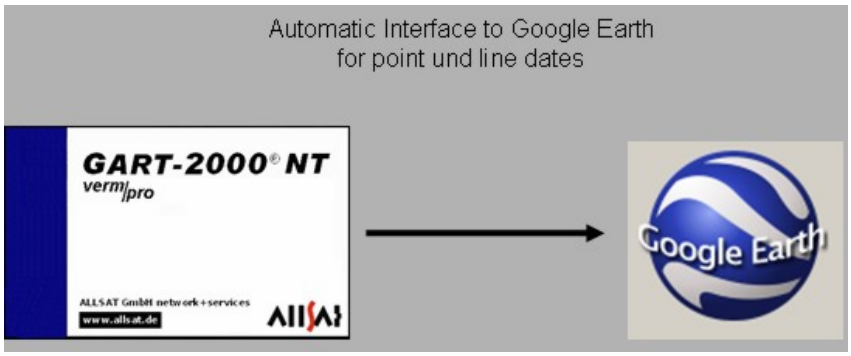


Figure 4-64: From GART-2000® to Google Earth

With Google Earth you have the possibility to check your measured points. You can see the 3D coordinates, point names, lines and other attributes . Under the menu item ***Output > Google Earth*** select a name for the Google Earth *.kml file. Now you can choose which points you want to export and Google Earth is opening automatically.

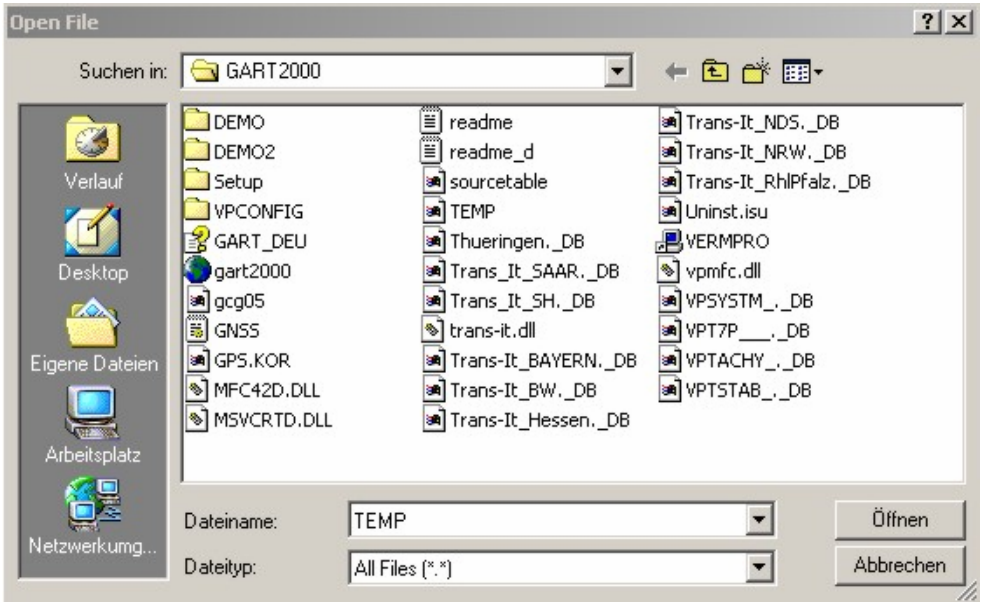


Figure 4-65: Open File

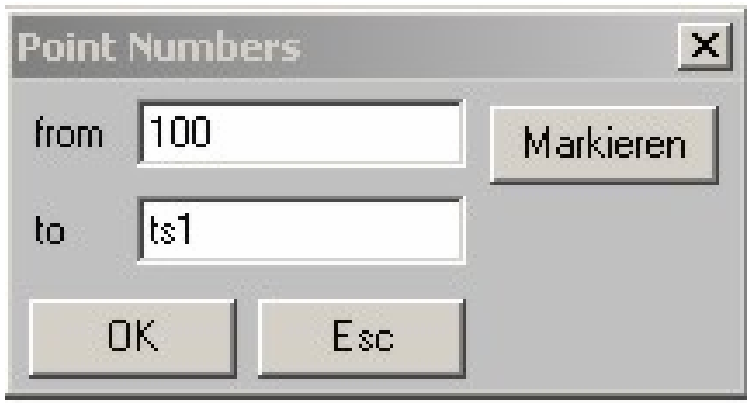


Figure 4-66: Point Numbers

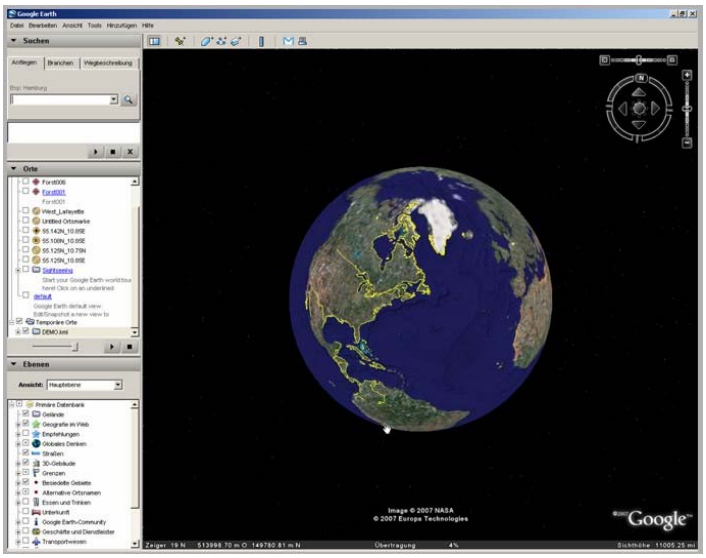


Figure 4-67: Google Earth

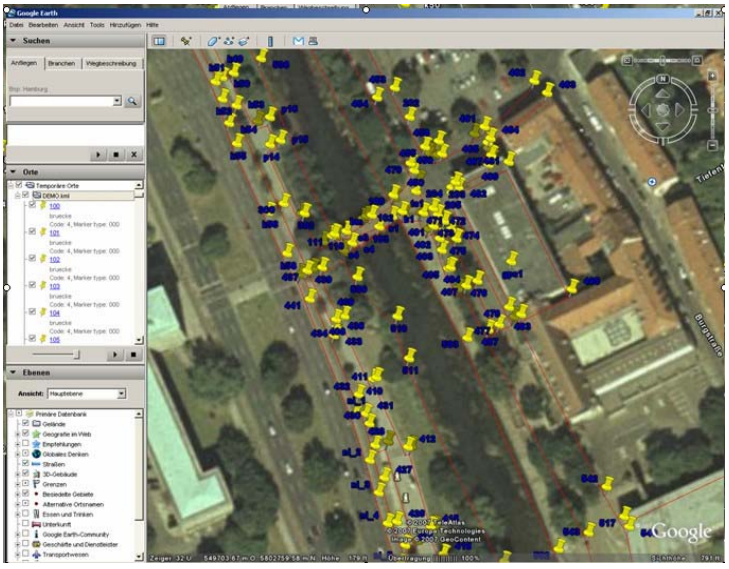


Figure 4-68: Demo Project in Google Earth

4.3 Calculate

GART-2000® CE offers real-time calculation functions that transform the registered measurements into coordinates; moreover diverse calculation functions like intersections, transformations and setting outs can be calculated with ***GART-2000® CE***.

To display the calculation functions choose ***Calculate*** in the main menu.

The provided calculation functions vary according to the program version. Only the calculation functions of your individual ***GART-2000® CE*** version are shown:

4.3.1 Intersections

The menu ***Calculate > Intersections*** contains five submenus:

- Intersection of Straight Lines
- Intersection Circle and Straight Line
- Intersection of Arcs
- Tangent on Circle
- Perpendicular Foot
- Fitting Straight Line
- Shift Point
- Resection
- Foresection
- Sidesection
- Cutting_with_direction_angle
- Cutting_with_direction_and_distance

4.3.1.1 Intersection of Straight Lines

With the function ***Calculate > Intersections > Straight Lines*** the intersection point of two straight lines can be calculated and stored as plane coordinates.

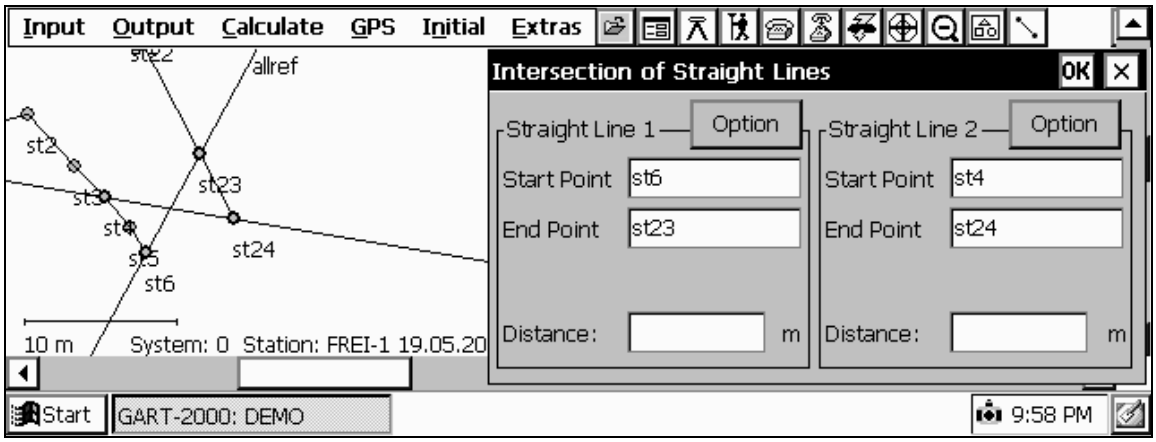


Figure 4-69: Intersection of Straight Lines

Define the start and end points of the two straight lines by entering the point numbers. Alternatively, click on the points in the graphic screen of ***GART-2000® CE***. The straight lines are displayed in the graphical screen.

To parallel-shift the straight lines enter the value in the field **Distance**. A positive distance moves the straight lines to the right, a negative distance results in a shift to the left. The orientation of the straight line is defined from start to end point.

With the **<Option>** button other definitions for the straight lines are possible.

By pressing the **<OK>** button the calculation of the intersection point is started.

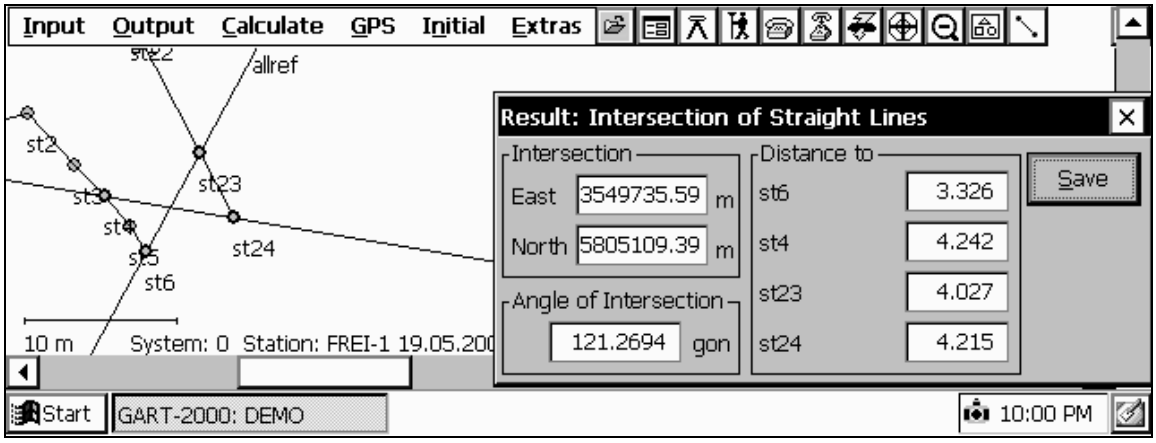


Figure 4-70: Result: Intersection of Straight Lines

As the result of the intersection of straight lines the plane coordinates of the intersection point, the angle between the straight lines as well as the distance between the intersection point and the 4 chosen points are shown.

If you want to store the coordinates click the **<Save>** button. The coordinate input dialog is opened automatically.

4.3.1.2 Circle – Straight Line

With the function ***Calculate > Intersections > Circle – Straight Line*** the intersection points of a straight line and a circle can be calculated and stored as plane coordinates.

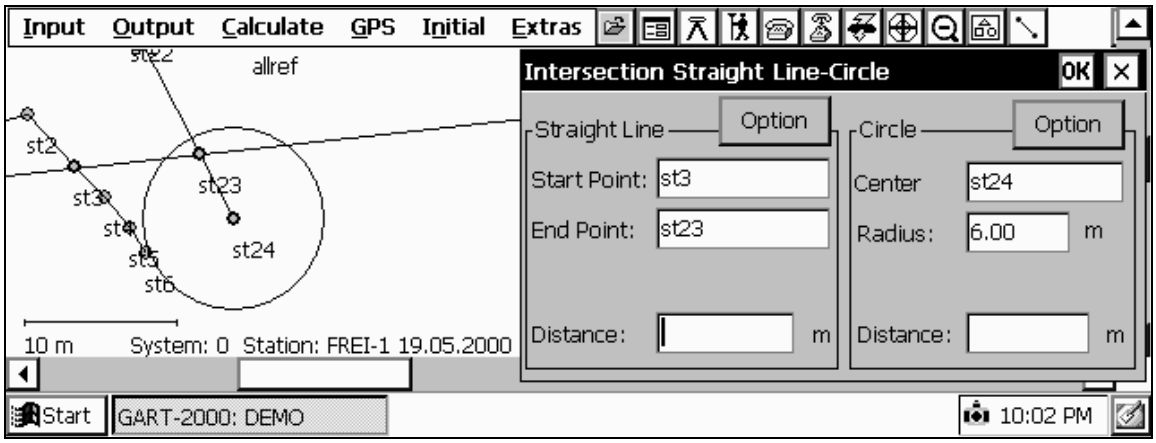


Figure 4-71: Intersection Straight Line - Circle

Define the start and end point of the straight line by entering the point numbers. Alternatively, click on the points in the graphic screen of ***GART-2000® CE***. Then choose the center point and the radius of the circle. The straight line and the circle are displayed in the graphic screen.

To parallel-shift the straight line enter the value in the field **Distance**. A positive distance moves the straight line to the right, a negative distance results in a shift to the left. The orientation of the straight line is defined from start to end point.

For the circle the input of a distance results in a shift of the intersection points on the arc. A positive distance shifts the intersections outwards, a negative sign results in a shift inwards.

With the **<Option>** button other definitions for the straight line and the circle are possible.

By pressing the **<OK>** button the calculation of the intersection points is started.

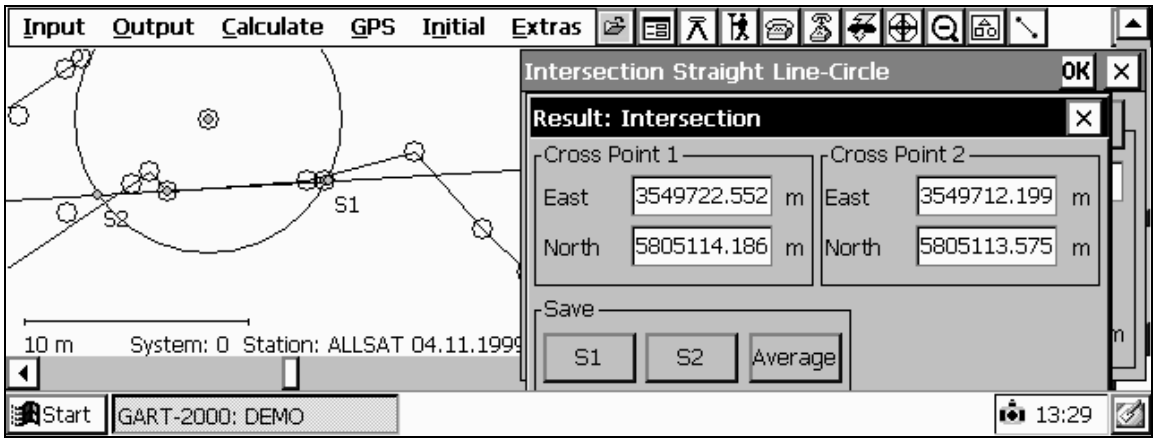


Figure 4-72: Result: Intersection Straight line - Circle

The result of the calculation shows the plane coordinates of both intersection points.

To store the coordinates of the intersection point 1 click the **<S1>** button; to store the coordinates of the intersection point 2 click **<S2>**. Alternatively, press **<Average>** to store the averaged coordinates of both intersection points. The coordinate input dialog is opened automatically.

4.3.1.3 Arcs

With the function ***Calculate > Intersections > Arcs*** the intersection points of two arcs can be calculated and stored as plane coordinates.

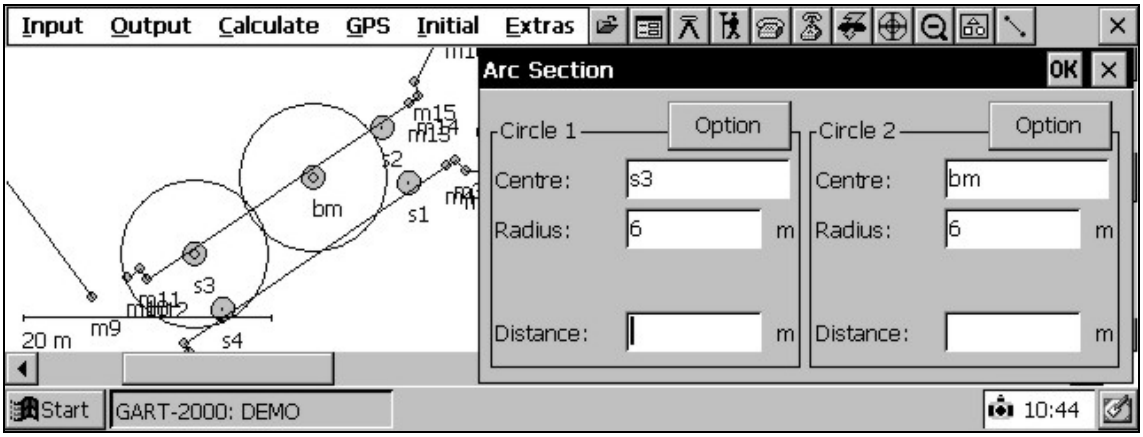


Figure 4-73: Intersection Arcs

Enter the center point number and the radius of each circle. Alternatively, click on the points in the graphic screen of ***GART-2000® CE***. The circles are displayed in the graphic screen.

For the circles an input in the **Distance** field results in a shift of the intersection points on the arc. A positive distance shifts the intersections outwards, a negative sign results in a shift inwards.

With the **<Option>** button other definitions for the circles are possible.

By pressing the **<OK>** button the calculation of the arc section is started.

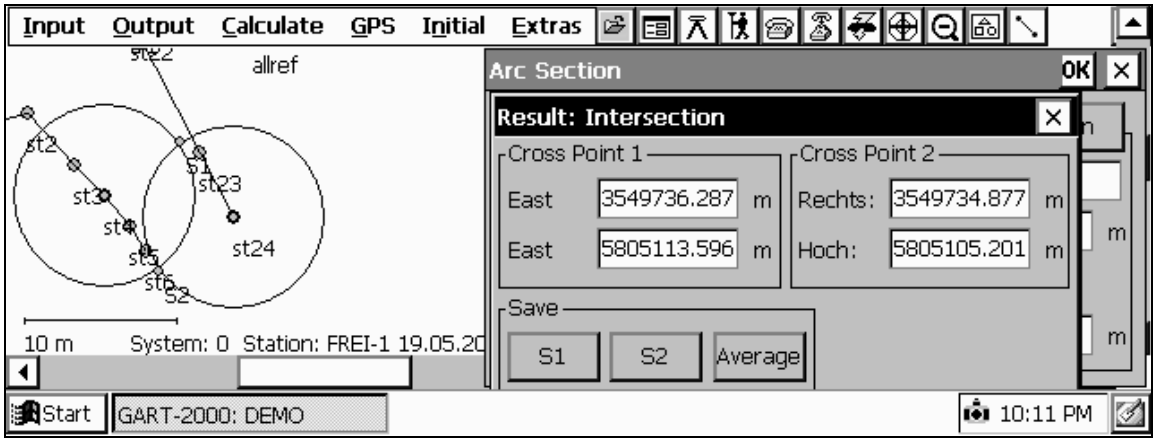


Figure 4-74: Results of Intersection Arcs

The result of the calculation shows the plane coordinates of both arc section points.

To store the coordinates of the arc section point 1 click the **<S1>** button; to store the coordinates of the arc section point 2 click **<S2>**. Alternatively, press **<Average>** to store the averaged coordinates of both arc section points. The coordinate input dialog is opened automatically.

4.3.1.4 Tangent to circle

With the function ***Calculate > Intersections > Tangent*** you can calculate the points of contact of the two tangents starting from a selected point and save these as coordinates.

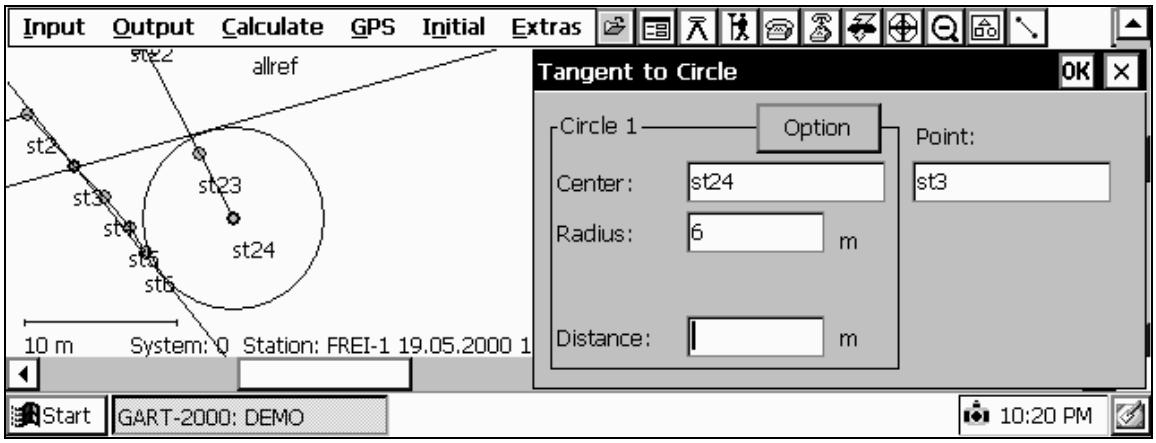


Figure 4-75: Straight line on arc

Specify the point by entering the point number. Alternatively, the point can also be clicked on in the ***GART-2000® CE*** graphical screen.

With the button **<Option>** the definition of the circles can be selected from a list.

The circle and the tangents are displayed in the graphic field.

By making an entry in the field **Distance**, the points of contact can be displaced if required.

The calculation of the tangent points is initiated by pressing **<OK>**.

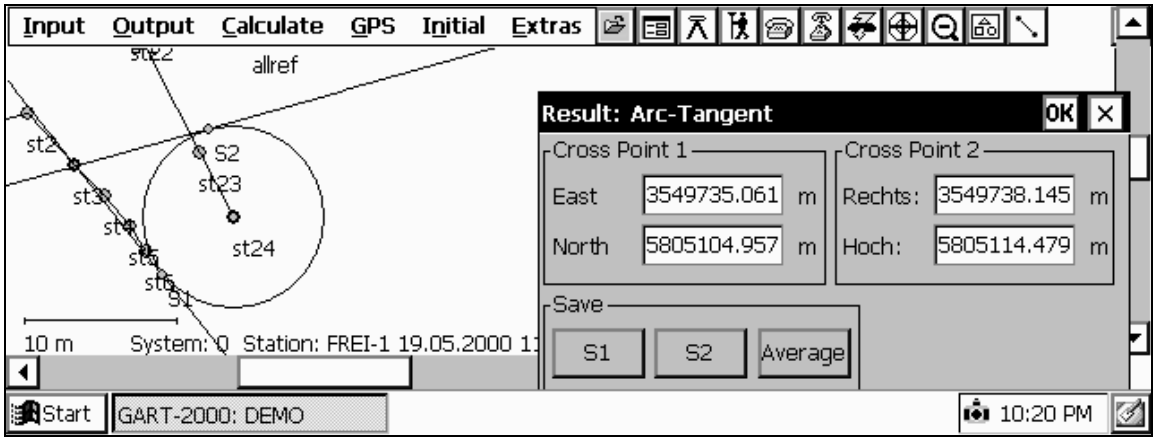


Figure 4-76: Result of straight line on arc

The calculation results in the output of positional coordinates for both points of contact (cross points).

If you wish to save the coordinates of Contact Point 1, click on the **<S1>** button; for the coordinates of Contact Point 2, click on **<S2>**, and for the averaged coordinates from both points, click on **<Average>**. You automatically enter the coordinate input menu, where you can allocate point numbers and save the points.

In the graphic field the cross points 1 and 2 are denoted by S1 and S2.

4.3.1.5 Perpendicular Foot

With the function ***Calculate > Intersections > Perpendicular Foot*** the perpendicular foot of a point to a straight line can be calculated and saved as a plane coordinate.

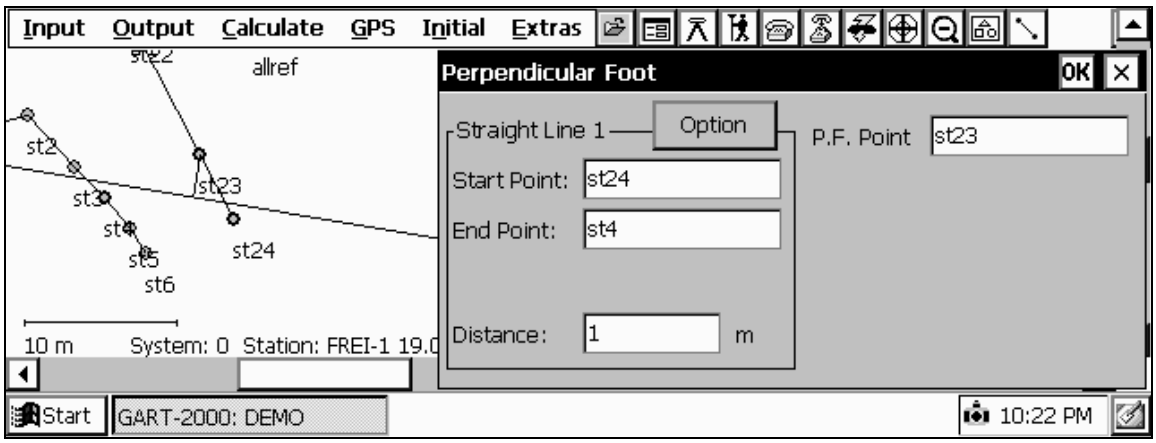


Figure 4-77: Perpendicular Foot

Define the start and end point of the straight line and the reference point by entering the point numbers. Alternatively, click on the points in the graphic screen of ***GART-2000® CE***. The straight line and the perpendicular line are displayed in the graphical screen.

To parallel-shift the straight line enter the value in the field **Distance**. A positive distance moves the straight line to the right, a negative distance results in a shift to the left. The orientation of the straight line is defined from start to end point.

With the **<Option>** button other definitions for the straight line are possible.

By pressing the **<OK>** button the calculation of the perpendicular foot point is started.

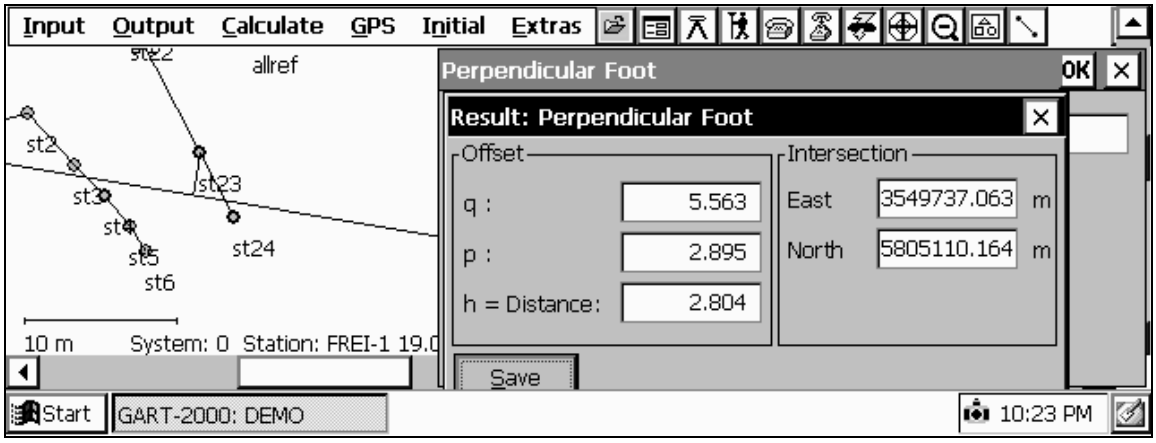


Figure 4-78: Results: Perpendicular Foot

The results of the calculation shows the plane coordinates of the perpendicular foot point, the distance between the perpendicular foot point and the start **p** and the end point **q** as well as the distance to the reference point **h**.

If you want to store the coordinates click the **<Save>** button. The coordinate input dialog is opened automatically.

4.3.1.6 Fitting Straight Line

With the function ***Calculate > Intersections > Fitting Straight Line*** the fitting straight line through a number of points can be calculated and the plane coordinates of the adjusted points can be saved.

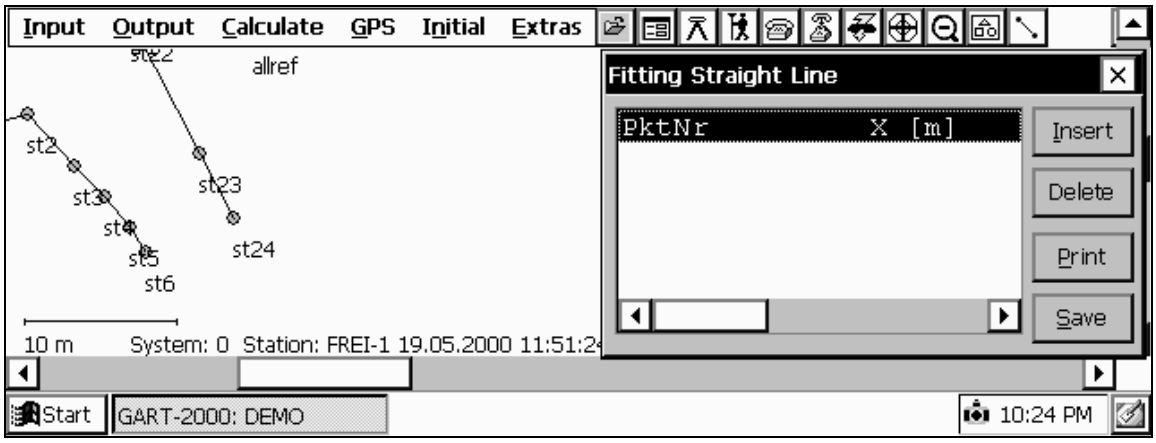


Figure 4-79: Fitting Straight Line

After the start of the function the point list is empty. With the **<Insert>** button points can be added to the fitting straight line.

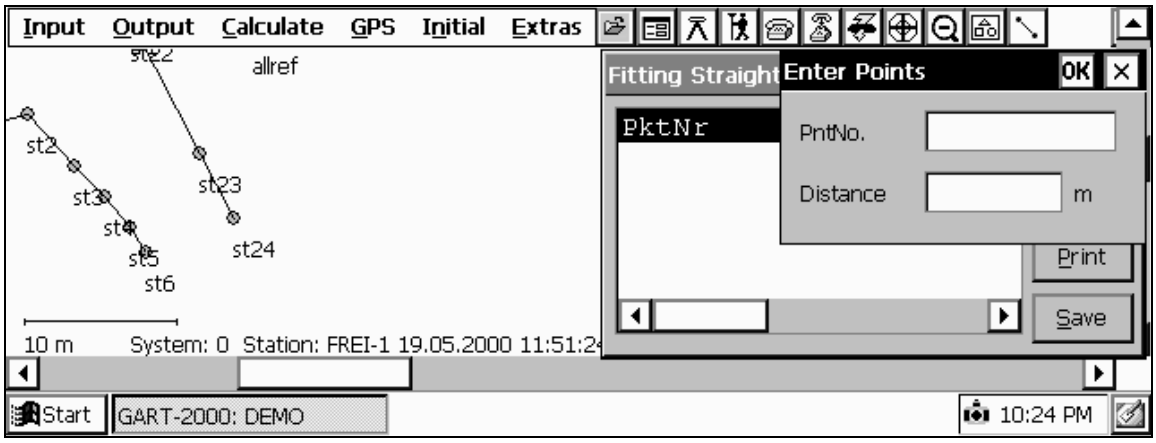


Figure 4-80: Enter Points for the Fitting Straight Line

Enter the point number in the **PntNo** field and click **<OK>**. Alternatively, click on the points in the graphic screen of ***GART-2000® CE***.

The field **Distance** allows the entry of a fixed distance from the point to the fitting straight line.

With the **<OK>** button the point is added to the list for the fitting straight-line adjustment. If the list contains more than two points the fitting straight line is shown in the graphic screen of ***GART-2000® CE***.

With **<X>** the input dialog can be exited.

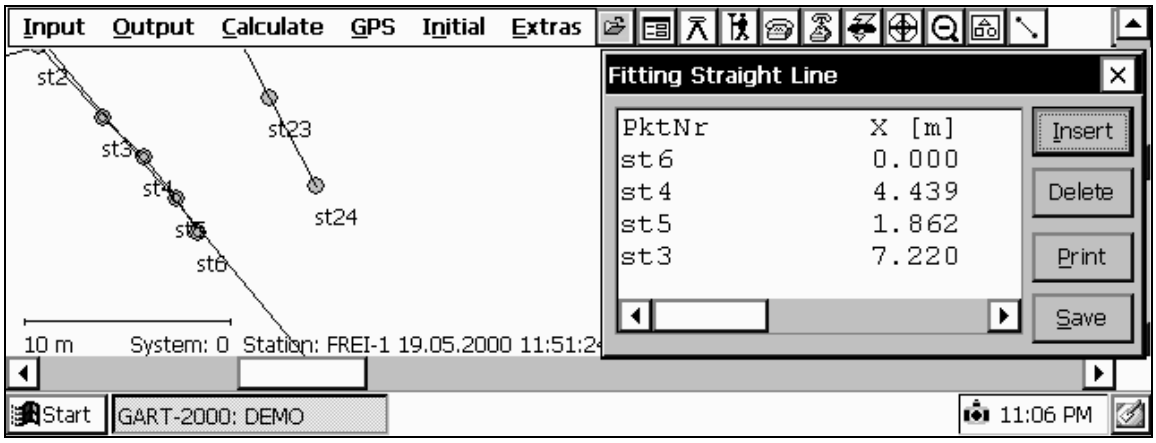


Figure 4-81: Results: Fitting Straight Line

With the **<Delete>** button points can be deleted from the fitting straight line.

The columns in the list contain the following information:

PointNo.	X-value	Y-value	vY
	(in straight line direction)	(fixed distance from the fitting straight line)	(correction in Y-direction)

With **<Print>** the adjustment results can be inserted into a file (see 4.5.5 Protocol).

With **<Save>** a selected point can be moved to the fitting straight line. The coordinate input dialog is opened automatically.

4.3.1.7 Shift point

The function ***Calculate > Intersections > Shift point*** shifts a point perpendicular to a line.

This function resembles the function Perpendicular Foot. Though, no new coordinate will be saved as perpendicular foot but the perpendicular foot will be saved with the existing point number. Thus, the point will be shifted to the line.

4.3.1.8 Resection

With a resection calculation the new point is determined by direction measurements to three points with known coordinates.

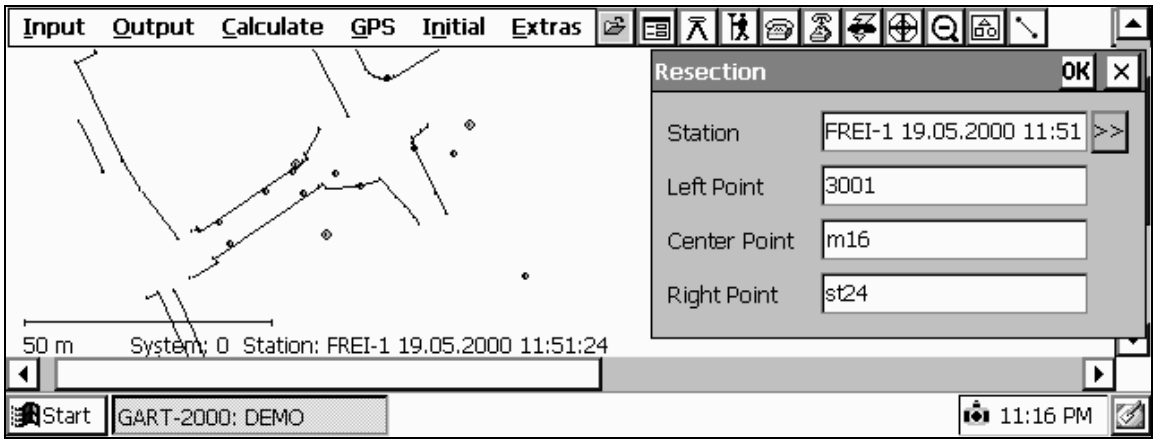


Figure 4-82: Input for calculating Resection

A resection can be calculated using this function. For this purpose, the necessary measurement values must be determined beforehand. The relevant station can be entered under **Station** or selected using the button **>>**. The three fixed points for the calculation can then be entered in the fields **Left Point**, **Center Point** and **Right Point** or selected by clicking within the graphic. The designation of the points as left, center and right does not need to be maintained for the calculation. After the **<OK>** button has been clicked, the new point is calculated and shown in the results dialog.

In the results dialog the new point can be adopted by pressing the **<Save>** button.

Note: If a multiple resection is to be determined, a single-point adjustment can be calculated under ***Calculate > Polar-/GPS-Transformation***. The measurements to the fixed points should then contain no distance data.

4.3.1.9 Foresection

With a foresection calculation a new point is determined by direction measurements from two stations. For this purpose, the necessary measurement values must be determined beforehand. The orientation of the two stations is performed by reciprocal collimation or by collimating points whose coordinates are known.

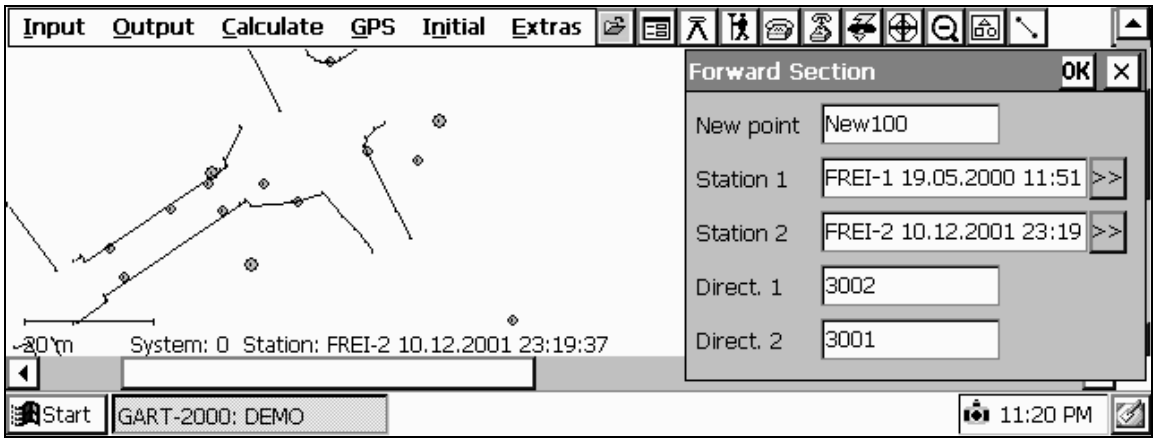


Figure 4-83: Input for calculation foresection

On calling up the function, the new point, the two stations and their connecting directions are queried. The stations can be selected from the station list using the **>>** button.

When this input has been confirmed by **<OK>**, the result of the calculation is displayed and can be adopted by clicking the button **<Save>**.

4.3.1.10 Sidesection

With a sidesection calculation a new point is determined by direction measurements from two stations, whereby a station is at the same time the new point. The orientation of the two stations is performed by reciprocal collimation or by collimating points whose coordinates are known.

On calling up the function, the new point, the two stations and their connecting directions are queried. The stations can be selected from the station list using the **>>** button.

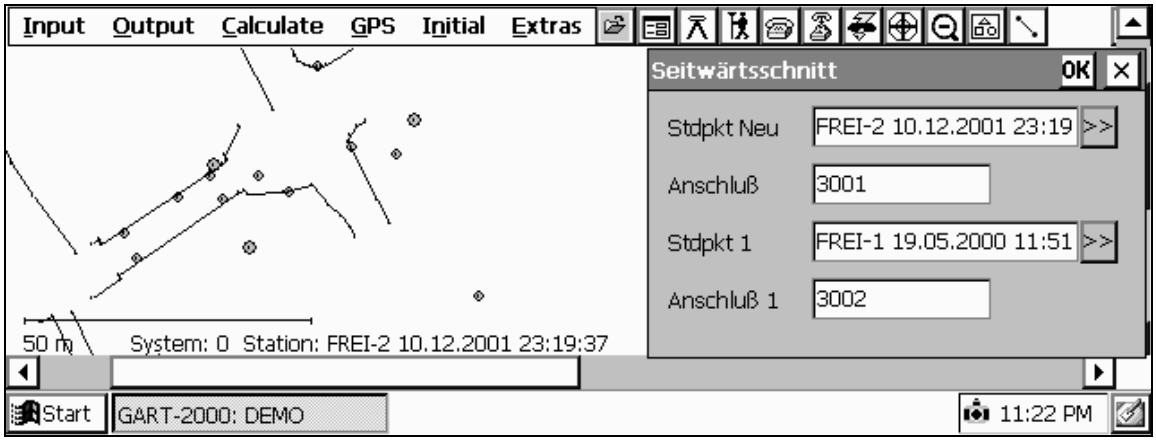


Figure 4-84: Sidesection

When this input has been confirmed by **<OK>**, the result of the calculation is displayed and can be adopted by clicking the button **<Save>**.

4.3.1.11 Intersection using bearings

Applying the function ***Calculate > Intersections > Intersection using bearings*** a new point can be measured using bearings.

The new point is the point which is measured from both stations.

After pressing the button **>>**, the ”**Choose Station”** dialog is opened. The **<OK>** button confirms the calculation of the intersection using bearings. The result is indicated and displayed within the graphic.

In the **“Choose Station” -** dialog the stations for the intersection using bearings are selected.

The indication of the results occurs after the calculation.

After pressing the **<Save>** button the dialog **<Save Coordinate>** appears for saving the intersection point.

4.3.1.12 Intersecsection using bearing and distance

Using the function Calculate > Intersections > Intersection using bearing and distance a station is defined by measuring the bearing to two fixed points and by measuring the distance to only one fixed point. Subject to the corresponding position of the points one or two solutions are possible.

If a unique solution can be calculated, it is displayed in the graphic as the intersection point S1. Additionally, the calculated coordinate is indicated in the dialog. Using <Save S1> the station coordinate is stored.

If two solutions are calculated, they are displayed in the graphic as intersection points S1 and S2. Also, the calculated coordinates is indicated in the dialog. By pressing <Save S1> or <Save S2> the possible station coordinate is stored.

If no intersection point can be calculated from the measurements and coordinates, a warning message appears.

4.3.2 Basic Tasks

With the menu ***Calculate > Basic Tasks*** basic calculation functions can be performed. These include the calculation of bearing and distance between two points and the calculation of a center of circle.

4.3.2.1 Bearing and Distance

The function ***Calculate > Basic Tasks > Bearing & Distance*** calculates the bearing and plane distance between two points. In addition, the distance related to the average local height (Gauss-Krüger-reduction and the height reduction applied) and the height difference are shown.

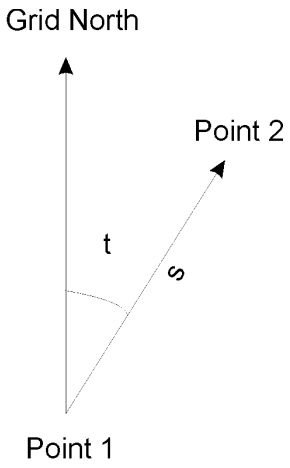


Figure 4-85: Definition of Bearing and Distance

Enter the point numbers and click **<OK>**. Alternatively, click on the points in the graphic screen of ***GART-2000® CE***. The points are marked in the graphic field and the calculation is started at once. If a new point is chosen this point is included in the calculation immediately.

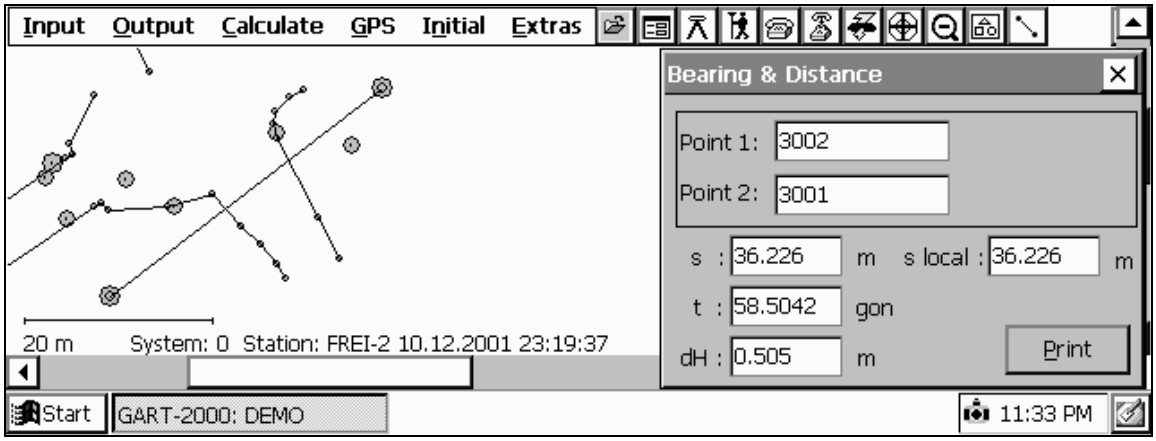


Figure 4-86: Bearing and Distance

GART-2000® CE calculates the bearing **t**, distance **s** and height difference ***dH*** between point 1 and point 2. In addition, the distance related to the average local height (Gauss-Krüger-reduction and the height reduction applied) is calculated.

With **<Print>** the calculation results can be inserted into a file or printed (see 4.5.8).

4.3.2.2 Center of Circle

The function ***Calculate > Basic Tasks > Center of Circle*** the center of a circle can be calculated and stored as a plane coordinate.

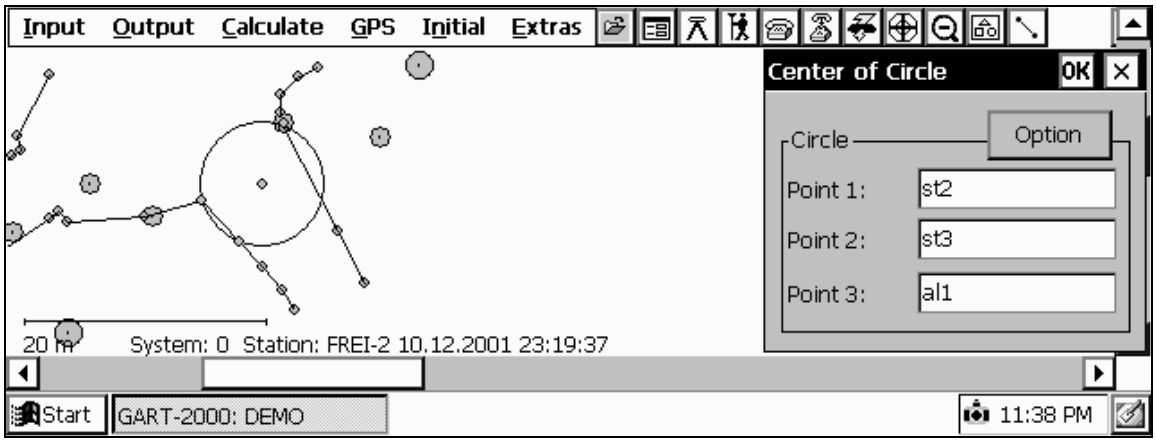


Figure 4-87: Center of Circle

Enter the point numbers and click **<OK>**. Alternatively, click on the points in the graphic screen of ***GART-2000® CE***. The points are marked in the graphic screen.

By pressing the **<Option>** button choose if the circle is to be defined by the center point and a radius, by the center point and the circle point, two circle points and a radius or by three points.

The circle is shown in graphic-screen.

By pressing the **<OK>** button the calculation of the center point of the circle is started.

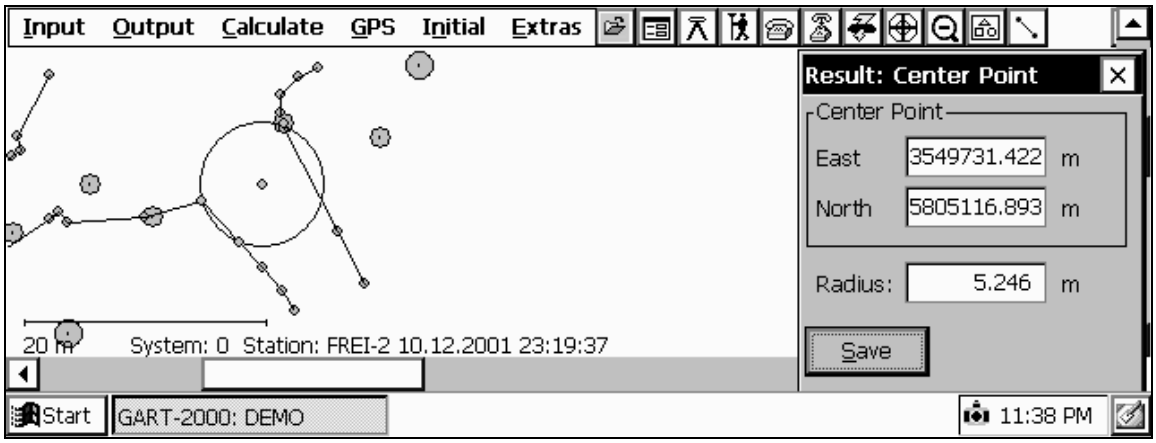


Figure 4-88: Result: Center of Circle

As the result of the calculation the plane coordinates of the circle center are shown.

To store the coordinates click the **<Save>** button. The coordinate input dialog is opened automatically.

4.3.2.3 Pythagoras Test

In the Pythagoras Test the measured hypotenuse of a right-angled triangle is compared with the calculated hypotenuse and the difference is displayed. The result can be protocolled by pressing the button **<Print>**.

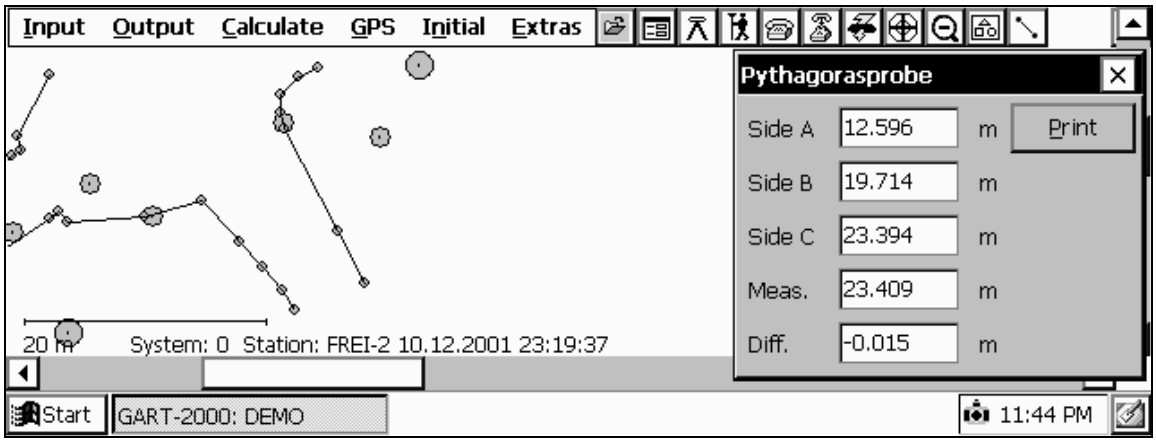


Figure 4-89: Input of Pythagoras Test

4.3.2.4 Control Measurements

If control measurements are to be made with a total station, this can be performed from any particular station by measuring the starting point and the end point of the line segment. The control measurement is then derived from the bearings and distances.

The tachymetric measurement of control surveys is called up through the menu function ***Calculate > Basic Tasks > Control Measurement***. After the total station being used has been selected, the following dialog appears:

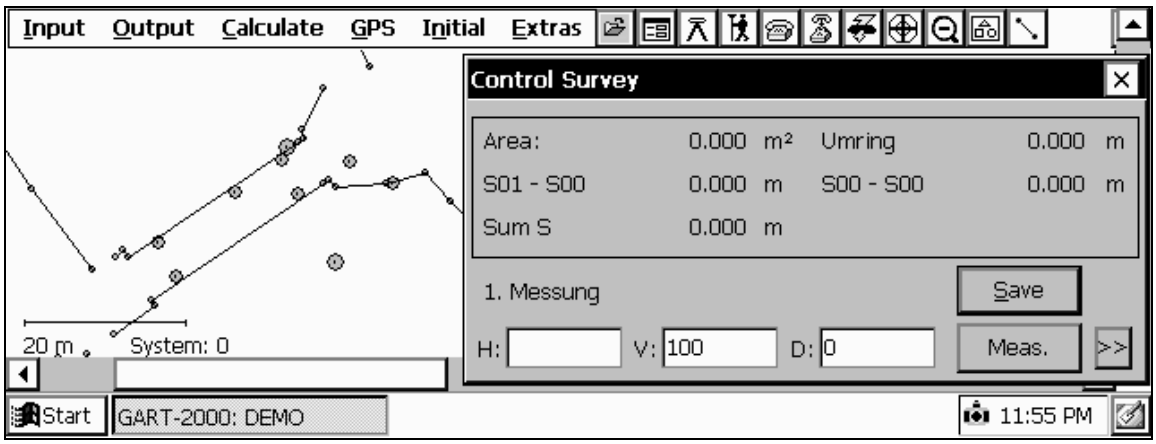


Figure 4-90: Input for Control Measurements

The first measurement takes place towards the starting point of the segment. By clicking the **<Meas.>** button, it can be repeated as often as desired before the measured values are registered by means of the **<Save>** button. For the 2nd measurement the end point is collimated; this point is simultaneously the starting point of the second control survey. If the first measuring point is collimated once again, a ring and area calculation occurs automatically. The **>>** button activates the control functions in the case of automatic tachymeters. You can quit the menu with **<X>**.

4.3.3 Setting Out

Under ***Calculate > Setting Out*** the possibility exists to set out points, spot elevations, detail points and alignments or to determine an arc between two points, depending on the ***GART-***

2000® CE version in use. Depending on the type of station chosen (see ***Input > Station***), the setting out can be performed by means of GPS or tachymeter.

4.3.3.1 Points

With the menu ***Calculate > Setting Out > Points*** a setting out of points with known coordinates can be performed.

4.3.3.1.1 Setting Out Points with GPS

To define the setting out and the orientation point, both, entering the point number and clicking on the point in the graphic screen are possible.

The functionalities of this menu correspond to those of the menu ***Input > Measurements.***

By pressing the **<OK>** button the difference of the current position related to the setting out / orientation point is calculated and shown numerically and in the graphic screen.

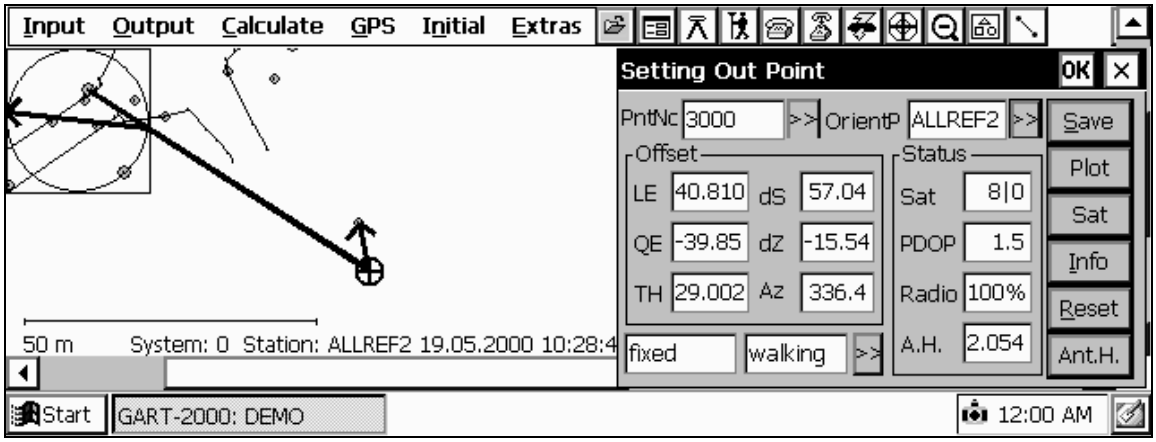


Figure 4-91: Setting Out Points with an Orientation Point

The following data are shown:

LE Difference in the direction to the setting out / orientation point [m]

QE Difference perpendicular to the setting out / orientation point [m]

Ds Linear distance difference from current position to setting out point [m]

DZ Height difference in the user system.

TH True Heading: user's current direction of movement, determined by the receiver

Az Azimuth from current position to setting out point [gon]

The difference of the current position to the setting out / orientation point is shown with a triangle. For Topcon receivers the compass in the upper left corner shows the true heading and the azimuth. If both arrows point in the same direction the user is moving towards the setting out point. This feature works only with movement.

To save the coordinates of the current position, click on the **<Save>** button.

If no orientation point is entered the differences shown relate to the position where the last click on the **<OK>** button occurred. With a new click on the **<OK>** button the reference position can be updated at any time.

The function **Auto Zoom** can be set to ***"No"*** in the ***Initial > Constants > GPS*** menu. In this case the graphic screen of ***GART-2000® CE*** shows always the user defined zoom area, whereas the zoom area is always updated if **Auto Zoom** is activated.

On pressing the button **<Plot>**, a polar representation of the setting-out situation is presented. In this way, the point to be staked out can be located within the vicinity.

Information on left side on screen mean:

dE Difference Easting

dN Difference Northing

dZ Difference of the Heights

dS Linear deviation

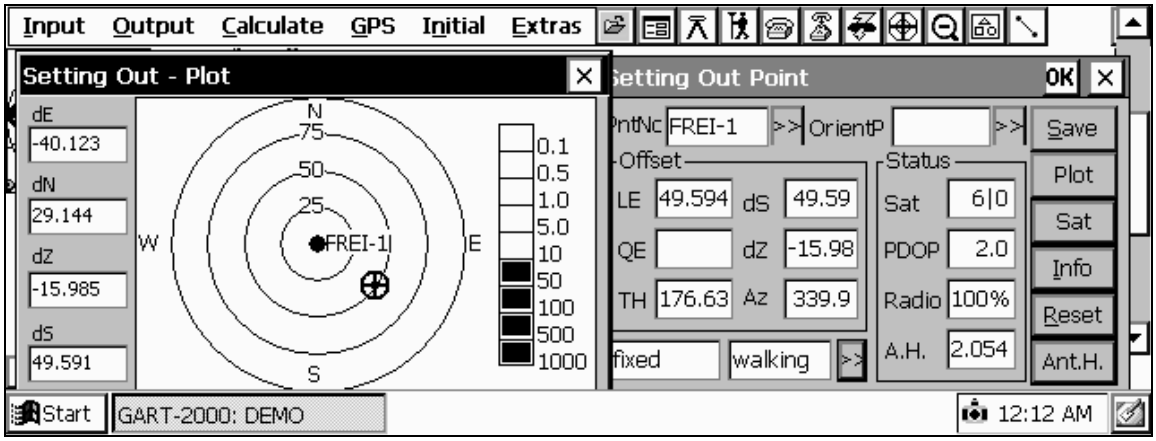


Figure 4-92: Setting Out Plot

The further buttons of the Setting Out dialog correspond to those of the Measurement menu ***Setting out Point*** with the total station.

4.3.3.1.2 Setting Out Points with Total Station

When the polar setting-out of points is performed with the aid of a total station, the point to be set out must be entered in the dialog window under **PntNo**. If the point exists in the point database, the setting-out elements are calculated immediately and output under **Set**. During calculation of the stake-out elements, reductions, instrument errors and any residual estimation are taken into account. This calculation takes place iteratively. If the set (standard) values cannot be calculated exactly, an error message occurs specifying the attained accuracy in East, North and Height.

When points without heights are set out, the height difference is assumed to be 0 and thus the preset elevation to be 100 gon.

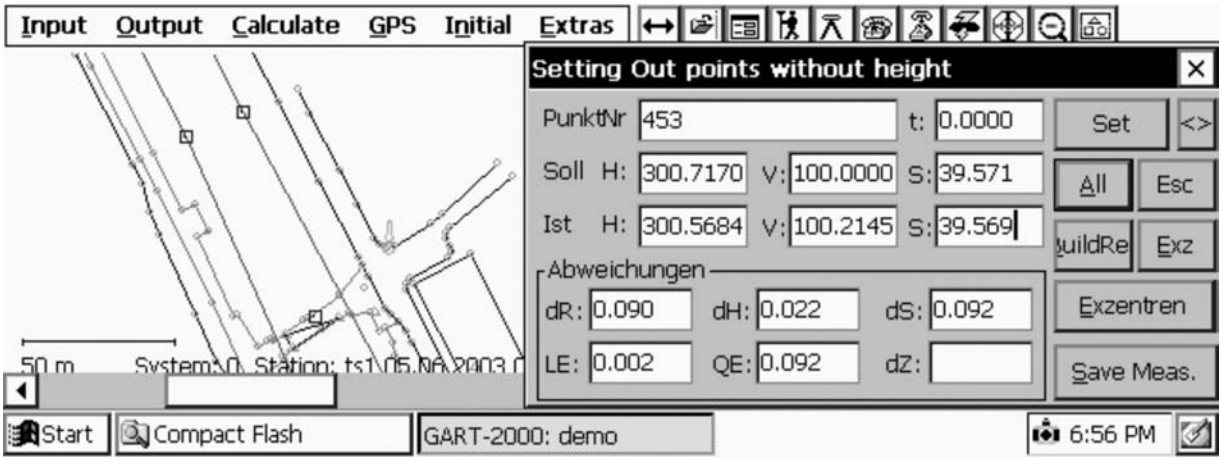


Figure 4-93: Setting out point with total station

<Set> sets the direction to the corresponding point in case of automatic total stations.

The measurement can be triggered by various buttons. **<All>** triggers an overall measurement, **<BuildRef.>** and **<Exz>** trigger a measurement to a reflector. When using the **<BuildRef.>** button, the amount of horizontal eccentricity is queried, and the amount of spatial eccentricity is queried when **<Exz>** is used.

When using the **<Excenters/Exzentren>** button, the longitudinal ex-center, the transverse ex-center and the distance eccentricity are entered.

The button **<>** switches into the control mode in the case of automatic tachymeters.

On pressing the button **<Save Meas.>**, the Measurement Registration dialog appears automatically.

The dialog can be quitted with **<X>** or with **<Esc>**.

4.3.3.2 Height points

4.3.3.2.1 Setting Out Height Points with GPS

See ***4.3.3.1 Setting Out Points***

4.3.3.2.2 Setting Out Height Points with Total Station

Setting Out is the same like Setting Out Points. Additional vertical angle **V** will be calculated.

4.3.3.3 Detail points

When setting out detail points, a measured line must first be defined. If this line is not defined, it will be queried when the function is called up. By clicking the button **<Define Line>**, the line can be altered at any time during the setting out.

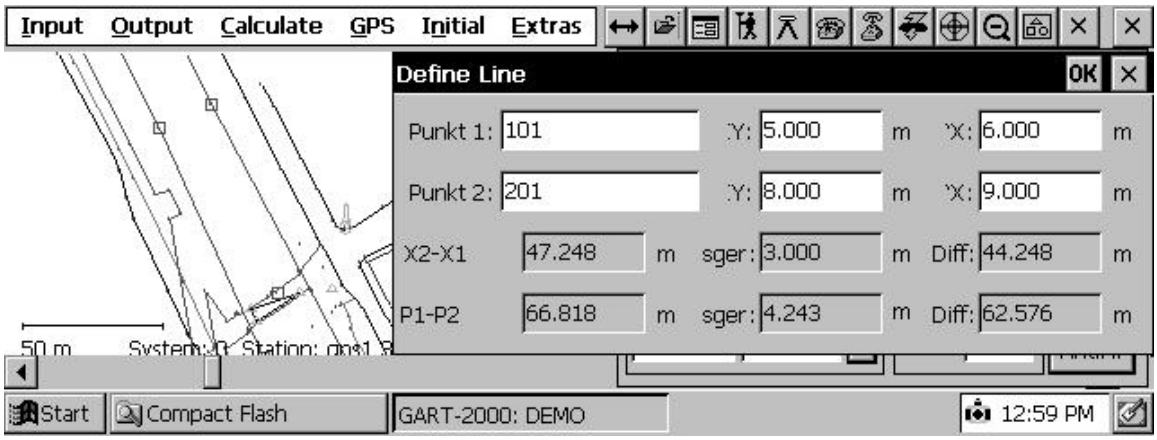

Input Output Calculate GPS Initial Extras
Define Line
OK
Punkt 1: 101 Y: 5.000 m X: 6.000 m
Punkt 2: 201 Y: 8.000 m X: 9.000 m
X2-X1 47.248 m sger: 3.000 m Diff: 44.248 m
P1-P2 66.818 m sger: 4.243 m Diff: 62.576 m
50 m
Start
Compact Flash
GART-2000: DEMO
12:59 PM

Figure 4-94: Define Line

4.3.3.3.1 Setting out detail points using GPS

After the measured line has been defined, the Setting Out dialog appears as follows.

In order to set out the detail points, the detail point quantities for **X** and **Y** of the measured line must be entered. The zero point (origin) of the local coordinate system used is the first point of the defined measured line. The X-axis is described by the measured line. The Y-axis runs perpendicular to this line. The standard values for the stake out are calculated as soon as the **<OK>** button is pressed.

The point to be staked out and the remote target can be entered either via the point number or by clicking the point in the graphic.

The functions in this window correspond to those of the window ***Input > Measurement***.

If the button **<OK>** is pressed, the deviation of the current position in relation to the remote target is calculated and displayed both numerically and graphically.

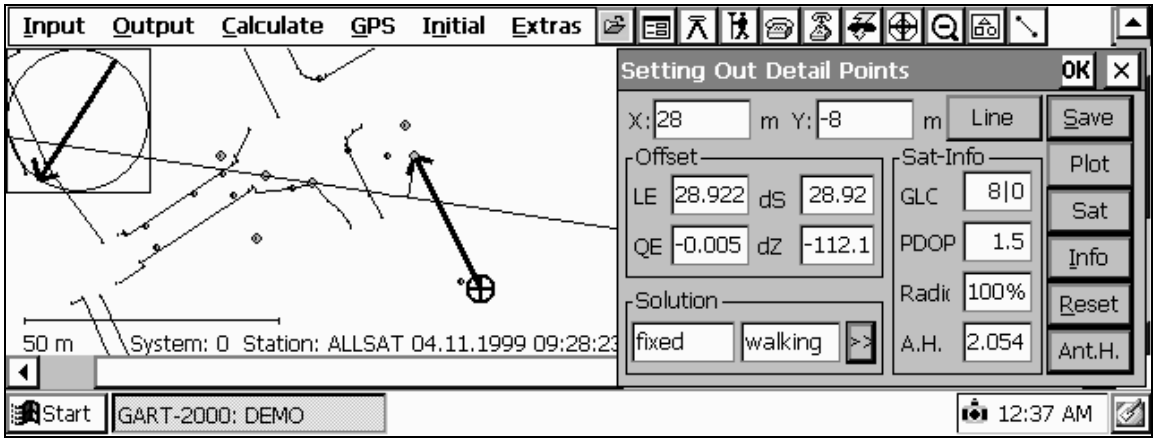


Figure 4-95: Setting Out point

Shown is:

LE longitudinal deviation from line

QE transverse deviation from line

dS linear deviation

dZ deviation in Height

The deviation of the current position from the point to be staked out is represented in the graphic screen by an error triangle. For TOPCON receivers, a compass in the upper left-hand corner shows the difference between True Heading and azimuth. If the arrow points upwards, you are moving directly towards the target point.

When you want to save the coordinates of the point to be staked out, press the **<Save>**-button.

The detail point quantities **X** and **Y** can be altered at any time. With the button **<OK>** the new detail point quantities can be updated at any time as a reference point for the setting out.

In the menu ***Initial > Constants > GPS*** you can deactivate the function **<Auto Zoom>**. In this manner, the graphic section you have selected always remains visible in the display of ***GART-2000® CE***, whereas an activated **<Auto Zoom>** during the measurement delivers a tracking view of the current position.

Pressing the button **<Plot>** changes the view into a polar representation of the setting-out situation. In this way, the point to be staked out can be located within the vicinity.

Information on left side on screen denotes:

dE difference Easting

dN difference Northing

dZ difference of the Heights

dS linear deviation

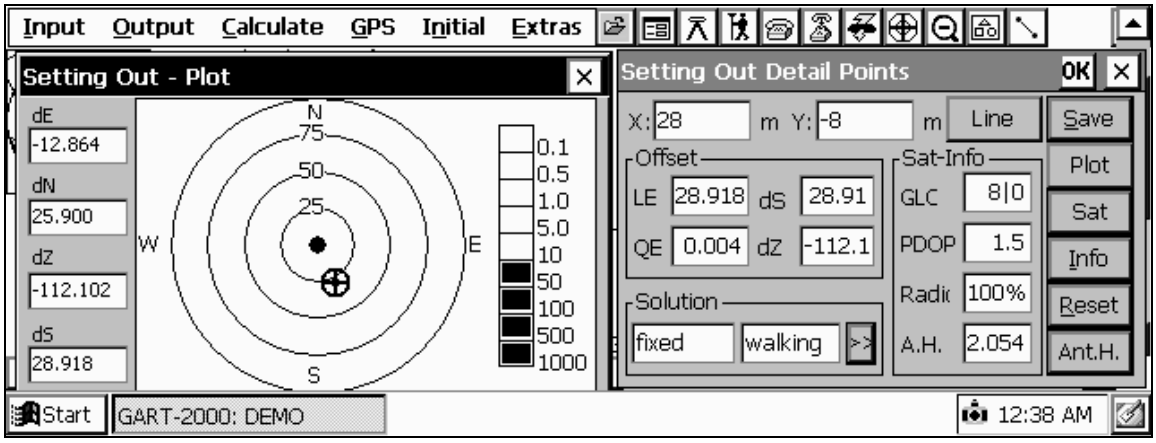


Figure 4-96: Polar description of Setting Out

The other buttons correspond to the Measurement dialog.

4.3.3.3.2 Setting out detail points with Total Station

After the measured line has been defined, the dialog for setting out the detail points appears as follows:

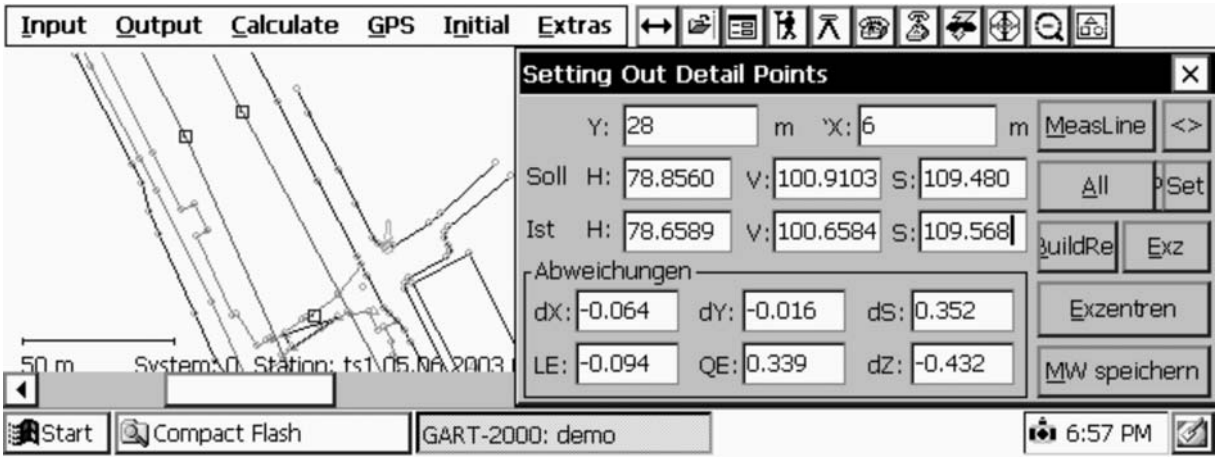


Figure 4-97: Setting Out Detail Points with Total Station

In order to set out the detail points, the detail point quantities for **X** and **Y** of the measured line must be entered. The zero point (origin) of the local coordinate system used is the first point of the defined measured line. The X-axis is described by the measured line. The Y-axis runs perpendicular to this line. Subsequently, the standard values for the stake out are calculated.

The measurement can be triggered by various buttons. **<All>** triggers an overall measurement, **<BuildRef.>** and **<Exz>** trigger a measurement to a reflector. When using the **<BuildRef.>** button, the amount of horizontal eccentricity is queried, and the amount of spatial eccentricity is queried when **<Exz>** is used.

<Set> sets the direction to the corresponding point in case of automatic total stations.

The button **<>** switches into the control mode in the case of automatic tachymeters.

By clicking the button **<MeasLine>** the measured line can be altered at any time during the setting out.

When using the **<Excenters/Exzentren>** button, the longitudinal ex-center, the transverse ex-center and the distance eccentricity are entered.

On pressing the button **<MW speichern>**, the Measurement Registration dialog appears automatically.

The dialog can be quitted with **<X>**.

Deviations are shown in the following data:

dX deviation from line in X

dY deviation from line in Y

dS linear deviation

LE longitudinal deviation from line

QE transverse deviation from line

dZ deviation in Height

On pressing the button **<Save MV>**, the Measurement Registration dialog appears automatically.

With **<X>** the dialog can be quitted.

4.3.3.4 Alignment

With the setting out of alignments lines can be translated into the locality. To this end, a straight line definition is called for. When the straight line has been defined, new measurement values are displayed as local coordinates in relation to the straight line.

4.3.3.4.1 Setting Out Lines with GPS

After the starting and end points of the alignment have been entered, the setting out parameters are calculated.

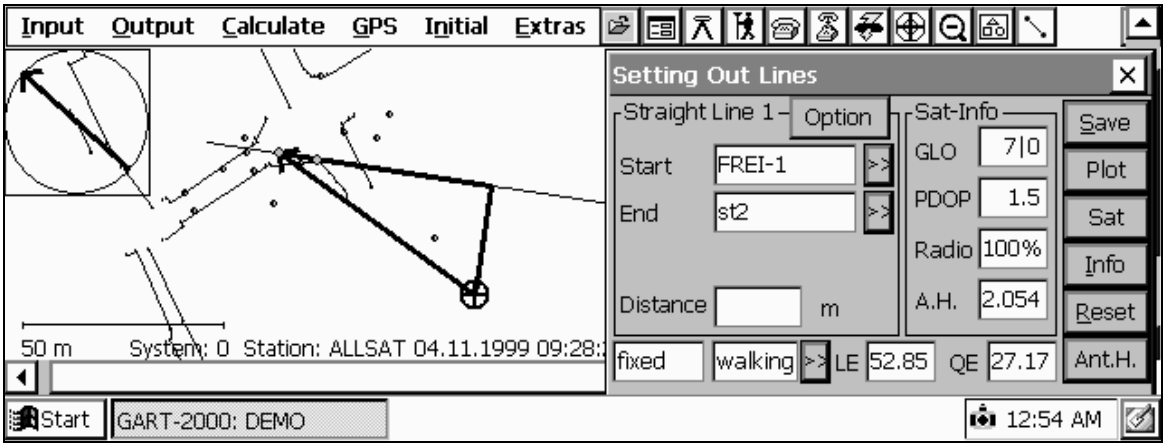


Figure 4-98: Setting Out Lines

The values in the fields **LE** and **QE** designate the longitudinal and transverse deviation from the alignment in relation to the starting point. The deviation of the current position from the point to be staked out is represented in the graphic screen by an error triangle. For TOPCON receivers, a compass in the upper left-hand corner shows the difference between True Heading and azimuth. The starting and end points can be entered either via the point number or by clicking the point in the graphic. The point can be selected from a coordinate list using the **>>** buttons.

The button **<Option>** allows further alignment settings to be made. Via the option ***"Fiducial Point"*** a compulsory point can be defined within the two points. The option ***"Perpendicular Point"*** sets the alignment perpendicular to the line between the starting and end points.

When you want to save the coordinates of the point to be staked out, press the **<Save>**-button.

In the menu ***Initial > Constants > GPS*** you can deactivate the function **Auto Zoom**. In this manner, the graphic section you have selected always remains visible in the display of ***GART-2000® CE***, whereas an activated **Auto Zoom** during the measurement delivers a tracking view of the current position.

Pressing the button **<Plot>** changes the view into a polar representation of the setting-out situation. With this representation and thanks to orientation by compass, the point to be staked out can be located more easily.

Information on left side on screen denotes:

dE difference Easting

dN difference Northing

dZ difference of the Heights

DS linear deviation

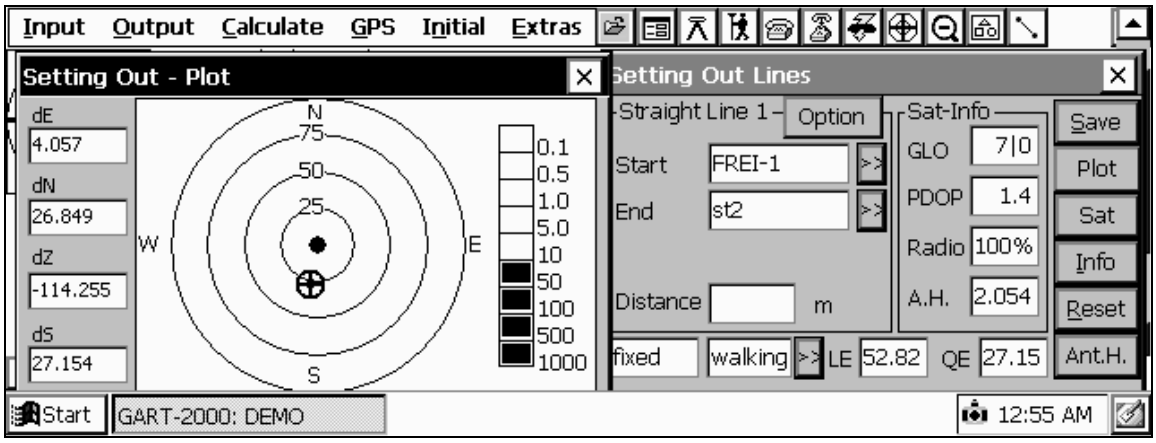


Figure 4-99: Setting Out Lines

The other buttons correspond to the Measurement dialog.

4.3.3.4.2 Setting Out Lines with Total Station

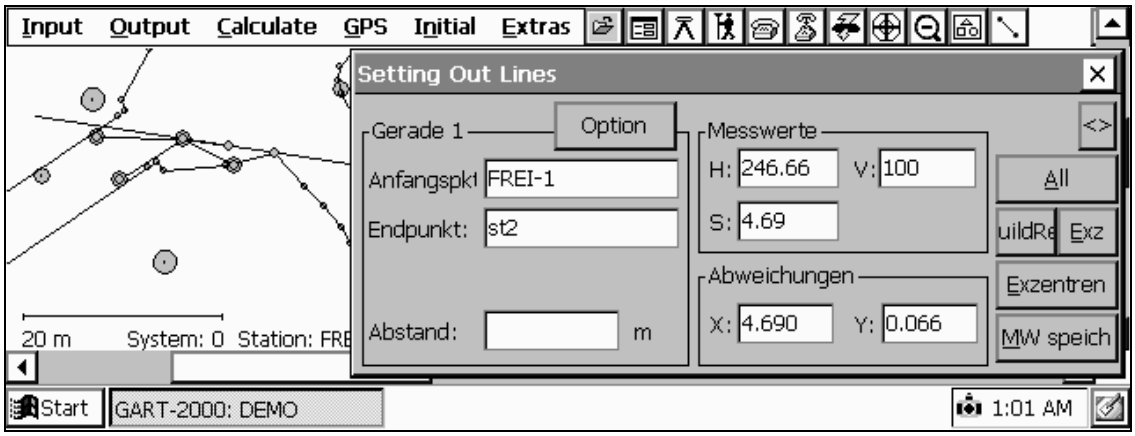


Figure 4-100: Setting Out Lines with Total Station

The measurement can be triggered by various buttons. **<All>** triggers an overall measurement, **<BuildRef.>** and **<Exz>** trigger a measurement to a reflector. When using the **<BuildRef.>** button, the amount of horizontal eccentricity is queried, and the amount of spatial eccentricity is queried when **<Exz>** is used.

When using the **<Excenters/Exzentren>** button, the longitudinal ex-center, the transverse ex-center and the distance eccentricity are entered.

On pressing the button **<MW speich>**, the Measurement Registration dialog appears automatically.

The button **"<>"** switches into the control mode in the case of automatic tachymeters.

Deviations are shown in following data:

X distance from starting point of line

Y side distance of line

S1 Distance of the last-but-one measured point (P1) from the intersection of the alignment with the straight lines P1-P2 (last measured point).

S2 Distance of the last measured point (P2) from the intersection of the alignment with the straight lines P1-P2.

The sign of the line segments **S1** and **S2** always applies in the direction from P1 to P2.

On pressing the button **<Save Meas.>,** the Measurement Registration dialog appears automatically.

With **<X>** the dialog can be quitted.

4.3.3.5 Arcs

Under the menu item ***Calculate > Setting Out > Arcs*** you can determine an arc between two points depending on the radius. The coordinates necessary for a stake out can be ascertained with different settings and saved.

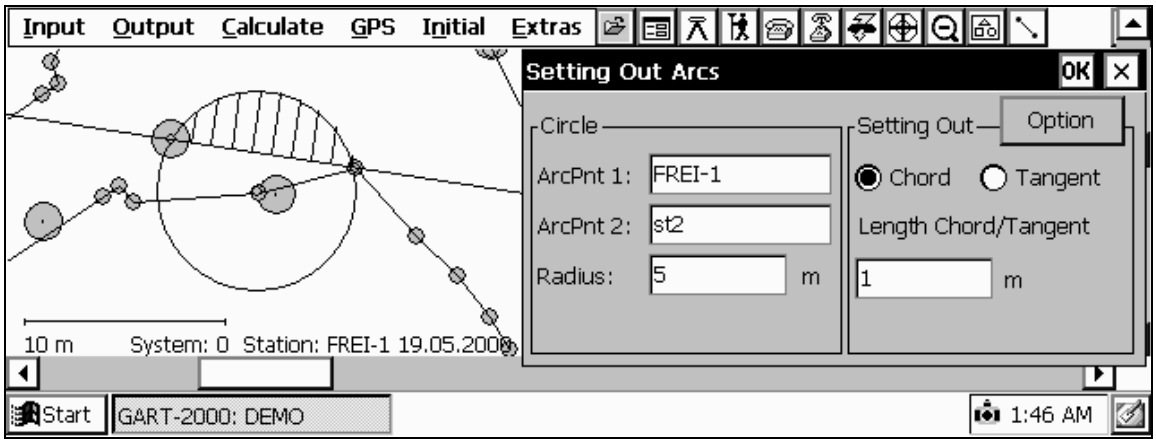


Figure 4-101: Setting Out Arcs

The arc points can be entered via point number or by clicking the point in the graphic. In addition, the radius of the arc must be specified.

The calculation of the points to be set can relate either to the ***"Chord"*** of the two arc points or to the ***"Tangent"*** of the first point on the arc.

The button **<Option>** enables different ways of determining the coordinates to be staked out. In the above example, the distance of the coordinates in relation to the chord amounts to 5m. The values set are accepted by pressing **<OK>**.

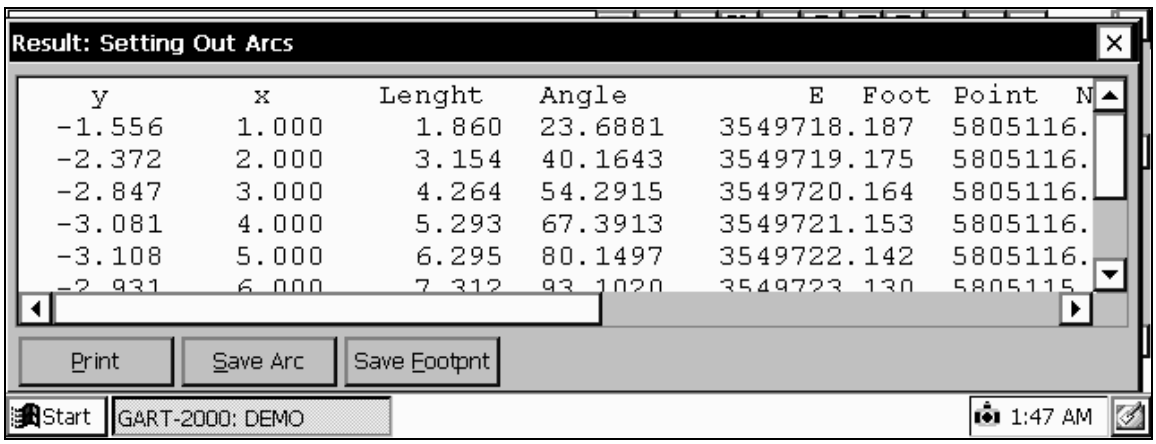


Figure 4-102: Result of Setting Out Arcs

The result can be protocolled by pressing the button **<Print>**. The coordinates to be set out can be saved as coordinates on the arc by pressing the button **<Save Arc>** or as footpoints by pressing **<Save Footpnt>**.

4.3.4 Polar/GPS Transformation

With the menu ***Calculate > Polar/GPS Transformation*** a local transformation can be calculated using identical points.

To perform a local transformation, choose the ***Input > Coordinates*** menu and enter the coordinates and point numbers of the control points.

When measuring the control points in the ***Input > Measurements*** submenu, make sure to use the same point numbers as entered before. Once you have measured your identical points, it is possible to calculate a transformation. Therefore choose the ***Calculate > Polar/GPS-Transformation*** menu.

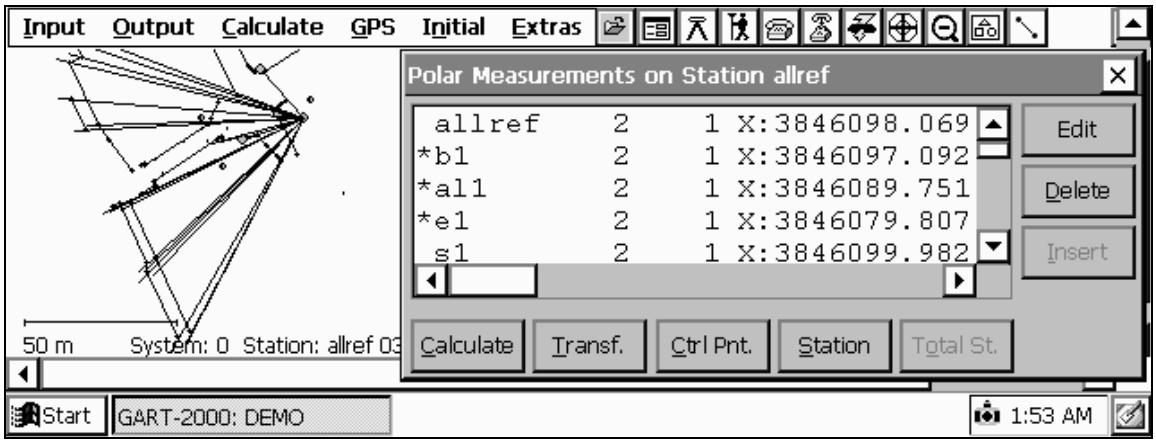


Figure 4-103: Polar/GPS-Transformation

First choose the kind of transformation with the ***Transf > Change*** button. To perform a standard local adjustment, use a 3-Parameter-Transformation without residual estimation.

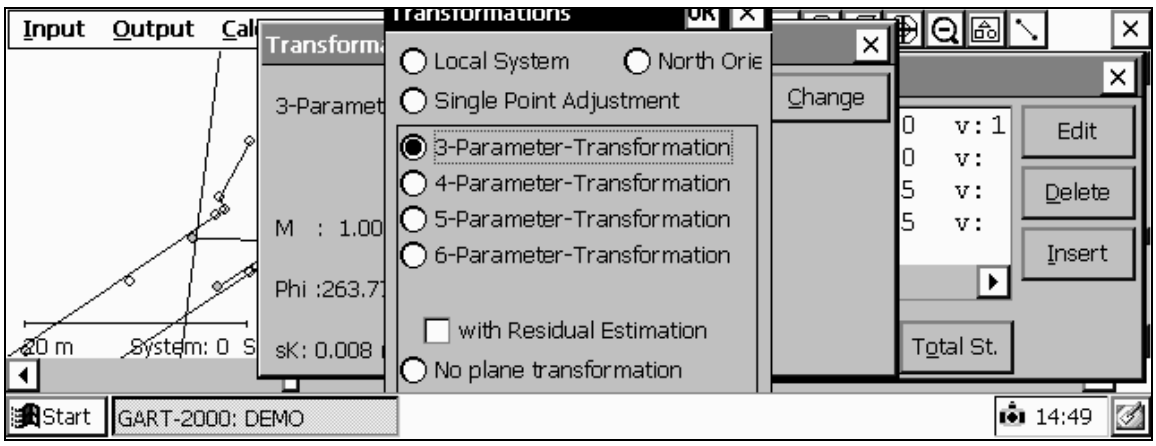


Figure 4-104: Kind of Transformation with Total Station

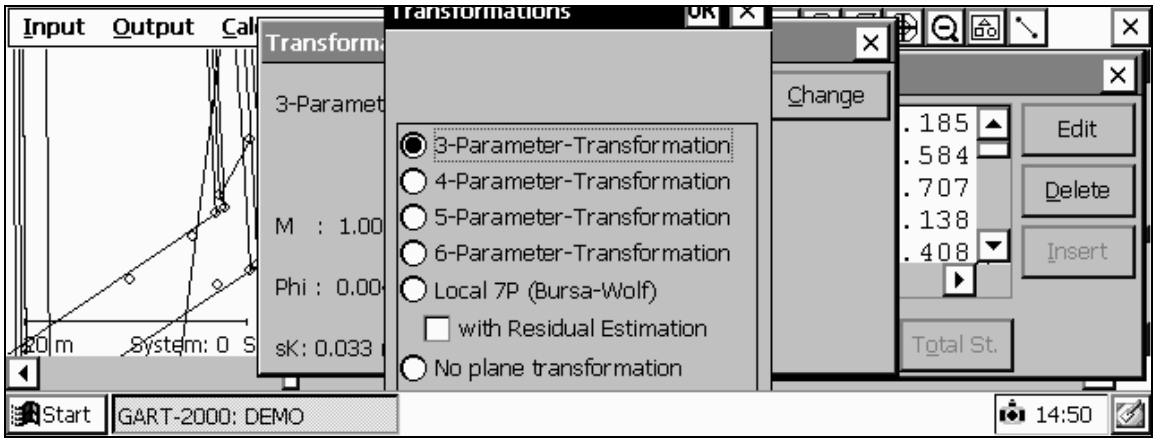


Figure 4-105: Kind of Transformation with GPS Station

The following transformation types are available in ***GART-2000® CE***:

- **3-Parameter Transformation:** the scale factor m is set to 1, calculations comprise the displacements in the x- and y-direction as well as the angle of rotation j of the coordinate system.
- **4-Parameter Transformation:** the scale factor m is calculated in addition to the 3-Parameter Transformation.
- **5-Parameter Transformation:** in contrast to the 4-Parameter-Transformation, a uniform scale factor m is not determined, but rather the respective scale factors mx and my for each coordinate axis.
- **6-Parameter Transformation:** in contrast to the 5-Parameter Transformation, not only a rotational angle is calculated, but also a separate angle of rotation for each coordinate axis (shearing, the rectangularity is abandoned).
- **Local 7P (Bursa-Wolf):** 3 translations (dx, dy, dz), 3 rotations (rx,ry,rz) and the scale factor m are calculated according to the Bursa-Wolf model. These parameters can be adopted into the global GPS constants.

Residual error distribution/weighting (1/s) can be optionally activated for the upper transformation types. For tachymeter stations, the transformation types local system, station summary and single-point adjustment are additionally available.

The **<Ctrl Pnt>** button shows the residuals for the control points.

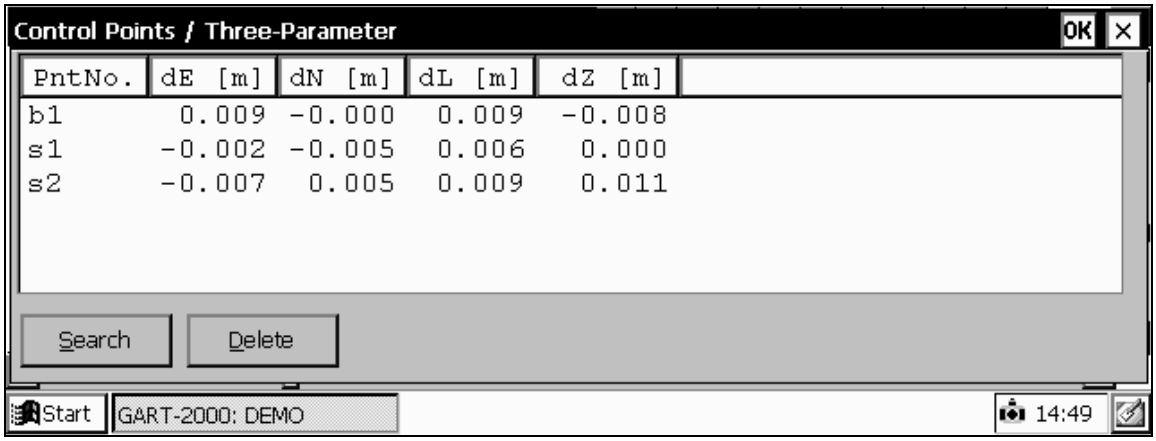


Figure 4-106: Control Points

Here just are shown points, what have been saved as control points.

To add a control point, choose the button **<Edit>** and activate on the checkbox **<Ctrl Pnt>**.

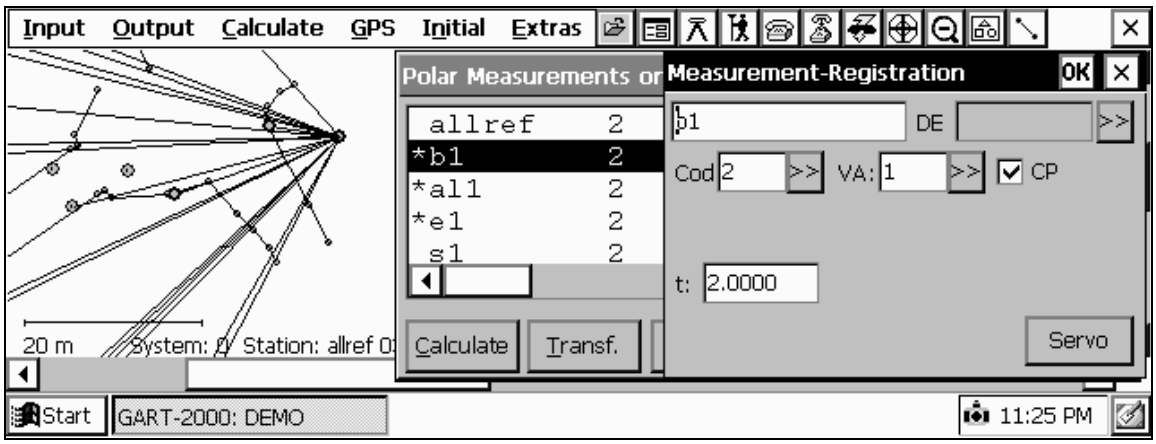


Figure 4-107: Edit Measurements

Use the button **<Calculate>** to start the transformation for all points orientated on the chosen station. The differences to the known coordinates are shown.

The calculated transformation affects the user coordinates. It is saved with respect to the station and is applied for all future measurements made on this station. ***GART-2000® CE*** uses the global 7-parameter transformation together with the projection chosen in ***Initial > Constants > GPS*** and with the local transformation chosen here. For the calculation of the transformation ***GART-2000® CE*** uses the measurements, not the user coordinates. For wrong saved points you should delete the coordinate and the measurement before restarting the transformation.

For a new station the old transformation cannot be applied. Optionally, a new transformation can be defined.

If you are working with a total station, you can display and monitor the instrument error saved for a station via the button **<Total Station>**. If the instrument errors have been incorrectly entered, these may be corrected. Since the instrument errors play a part in the calculation of the station coordinates, the calculation must be performed again following any correction by clicking the button **<Calculate>**. In that case, all the measured and previously calculated coordinates of the points on that station are computed in the light of the new instrument data**.**

4.3.5 Area

The Area Calculation function is only available with the purchase of the ***GART-2000® CE*** module "Complex Calculations".

4.3.5.1 Area

The function ***Calculate > Area >Area*** is available for the calculation of areas.

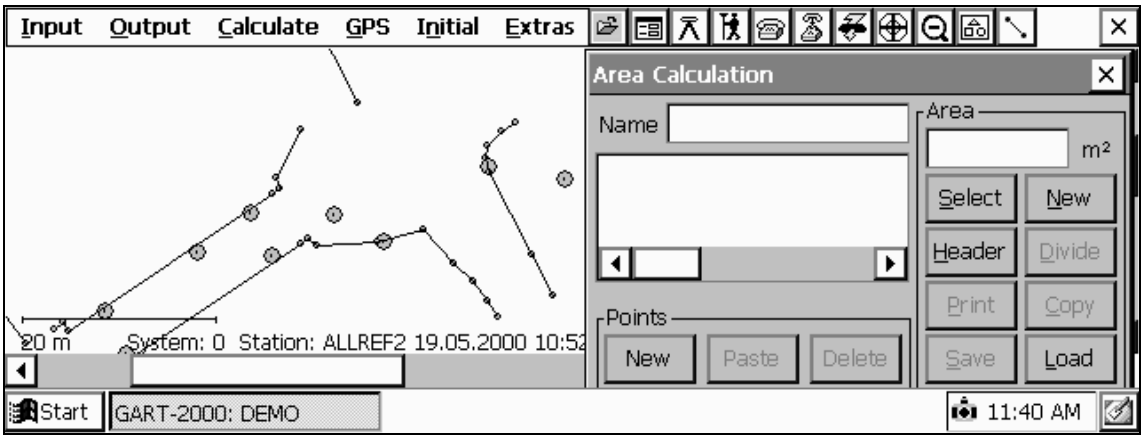


Figure 4-108: Area Calculation

In the section **Area** you can address sectors that are already confined by lines as an area via the button **<Select>**. Using the command **<Load>**, you can call up areas that have been saved. A manual input is possible in the section **Points** via the button **<New>**.

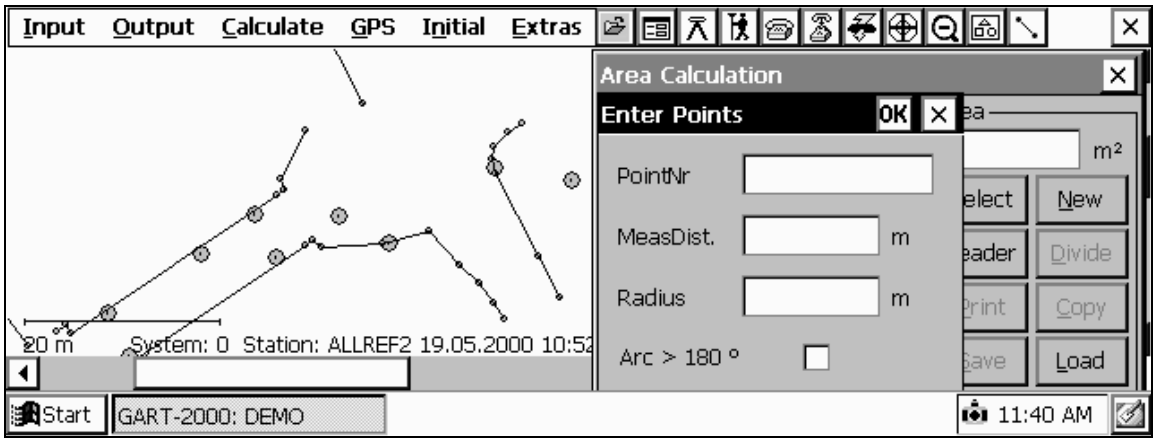


Figure 4-109: Input points for area definition

The input can be made by an entry in the field **PointNr** or by clicking the points directly. With the button **<OK>** the selected point is accepted and a further area point can be defined. The dialog can be quitted by pressing **<X>**.

After the area has been selected, the associated points and the area information are displayed.

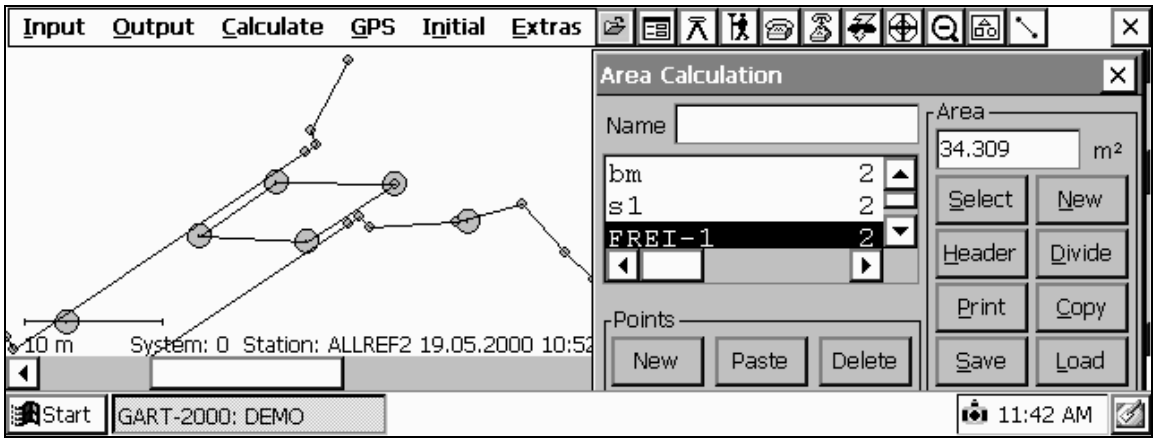


Figure 4-110: Result of Area Calculation

The area corresponds to the area at ground height. If reductions are activated, these are implemented beforehand.

In the list of points the coordinates and vertical curve radius are displayed as well as the point numbers and point codes.

With the aid of the buttons **<New>** and **<Paste>** in the section **Points**, points can be adopted into the point list and thus included in the area definition. The points within the list can be edited by double-clicking them.

In addition to the point number, a control survey that has been measured can be entered in the point input dialog under **MeasDist.** The control measurement applies to the next point. If the current point is the last point, the control measurement applies up to the first point.

The **Radius** denotes the internal radius of the line. A negative radius means that the center of the circle lies to the left of the line.

Arc > 200 gon means that an arc with aperture > 200 gon is used.

The function of the buttons in the section **Points**, with which the list of points can be edited, is as follows:

<New>	A new point is added to the end of the list. The point can be selected by clicking on it or by entering the point number.
<Paste>	A new point is inserted in front of the marked point. Input is executed as with **<New>.**
<Delete>	The marked point is deleted.

The buttons in the section **Area** have the following functions:

<Select>	An area that is already enclosed by lines can be selected by clicking.
<New>	Discards the previous area. A new input is required.
<Header>	By pressing this button a dialog is called up where the header data for the area are entered. These data are used for the protocol process. The dialog is quitted with **<OK>**.
<Print>	The area calculation is protocolled.
<Save>	The area calculation can be saved to a file. This file has the extension .FLA.
<Load>	An area calculation is loaded.
<Copy>	The name of the area and the area points are copied into the Clipboard. This serves purposes of data exchange with other programs.

<Divide> The Area Division dialog is called up (see below).

Area division

The Area Division function is called up via the button **<Divide>**.

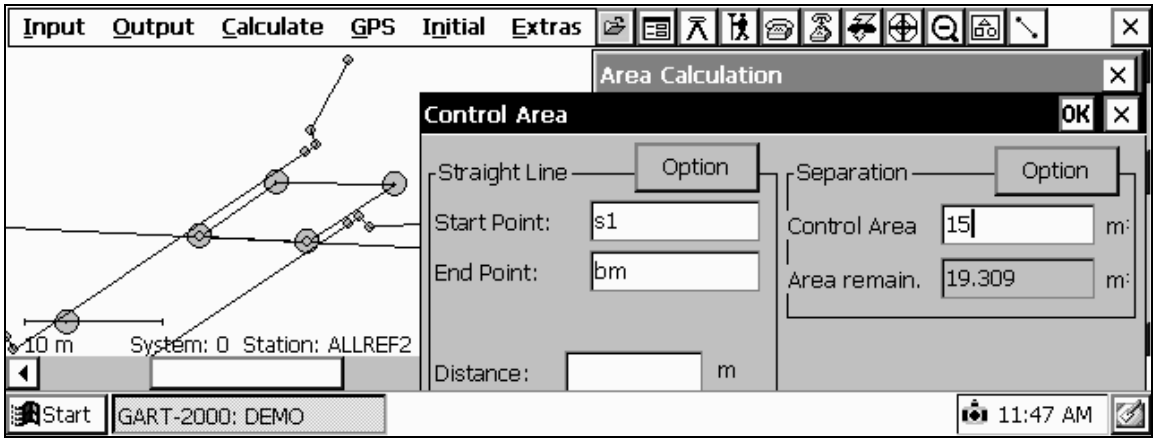


Figure 4-111: Area Calculation

For this division, the reference line must first be entered. The reference line lays down the line to which the area is to be divided in parallel. If the reference line lies within the area, the division takes place to the left of the starting point in the direction of the end point. With the aid of the field **Distance** the reference line can be displaced. Under **<Option>** this line can be led through a fiducial point or a footpoint.

In the field **Separation,** a separation dependent on a control area and several identical areas can be selected under **<Option>**. The separation is then performed in accordance with the size of the control area or the number of identical areas.

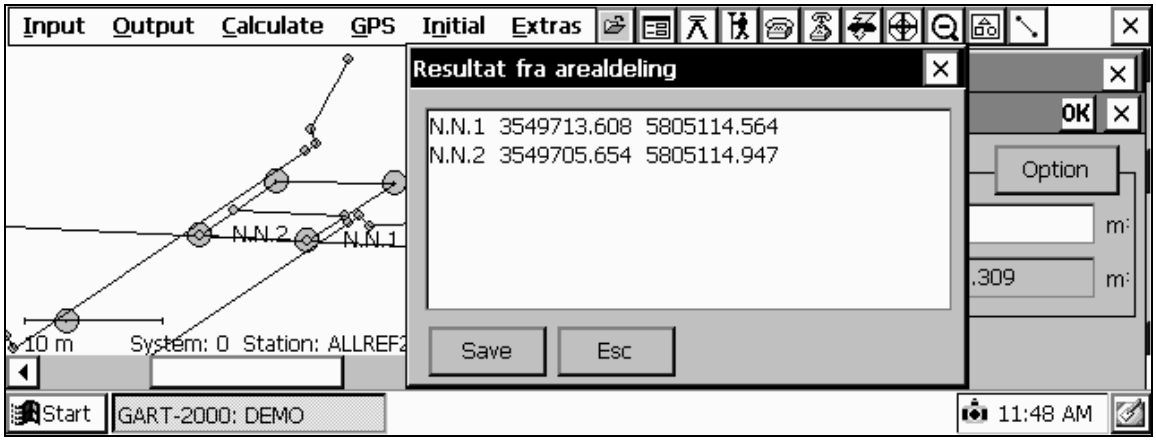


Figure 4-112: Result of Area division

After **<OK>** has been pressed, the new points created by the area division are displayed in a list and in the graphic.

The points can be saved by pressing the button **<Save>**, whereby the new point numbers and point codes are then queried.

4.3.5.2 Possession (only in GART-2000® NT and Viewer)

Using the menu ***Calculate > Area > Possession*** it is possible to divide an area defined by name and dimension of the area. The division is carried out proportionally to the total area, rounded down to full metres. The remaining value can only be entered manually.

Pressing the button **<Read>** an area stored before under ***Calculate > Area > Area*** can be imported as a total area.

By clicking the button **<Paste>** partial areas can be defined in order to insert single areas. If necessary, the inserted partial areas can be removed again by applying the button **<Delete>.**

The partial areas are divided proportionally relating to the total area. Additionally, the corrections of the partial areas and/or the difference to the total area is indicated.

The result can be stored in an output file by pressing the button **<Output>**. Using the button **<Copy>** it is possible to copy the result into the clipboard.

4.3.6 Grid

The Grid Calculation function is only available with the purchase of the ***GART-2000® CE*** module "Complex Calculations".

With the aid of the menu item ***Calculate > Grid***, new points can be calculated on a grid.

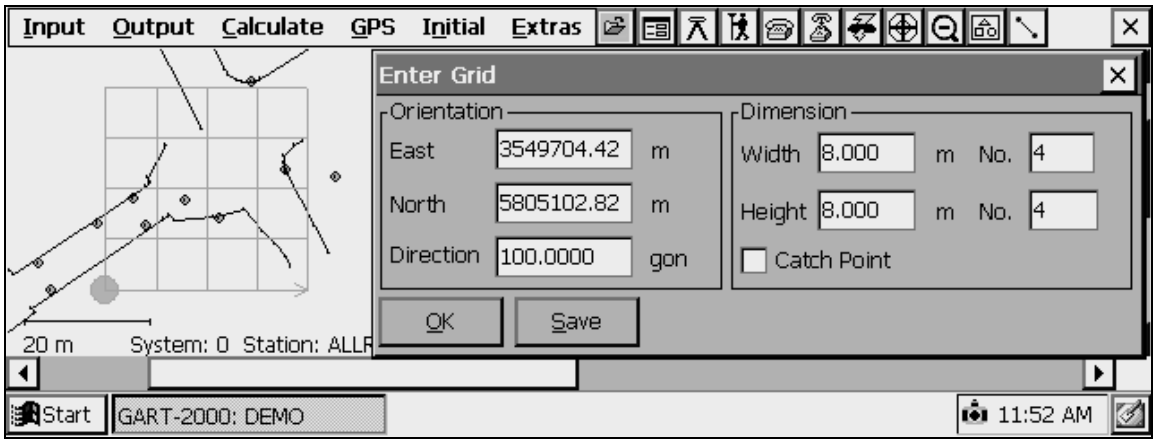


Figure 4-113: Grid calculation

In the section **Orientation** a starting point and the direction of the grid must be specified. When the dialog is called up, the coordinates of the lower left-hand point in the current screen segment are initially given. In the section **Dimension** the mesh size of the grid network (width) and the extension of the grid (height) are laid down.

The button **<OK>** computes the grid and represents it graphically. It is only when the **<Save>** button is pressed that the new points are adopted into the coordinates list.

The grid can be displaced via the starting point. A rotation is performed via the arrow on the lower right-hand side.

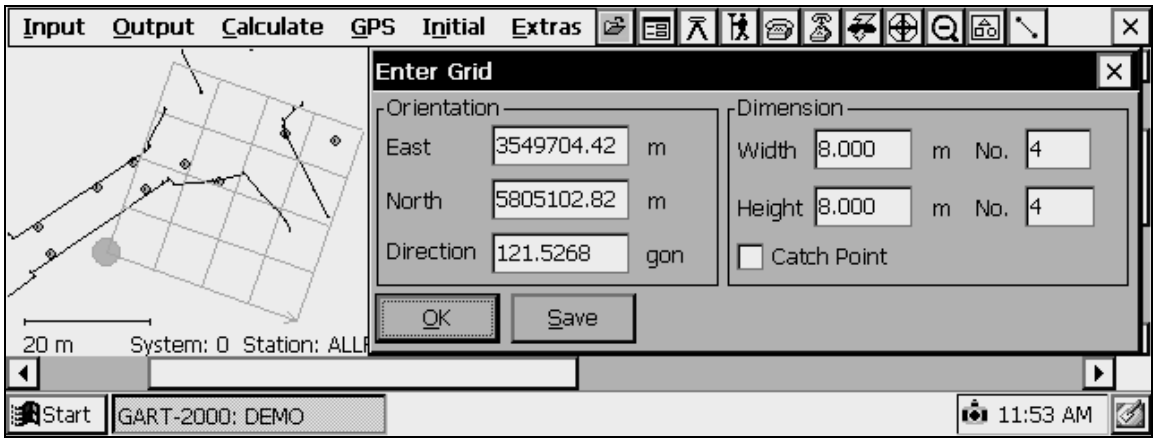


Figure 4-114: Change of grid position

If the grid displacement and rotation is to be allocated to existent points, the option **<Catch Point>** should be activated.

The dialog is quitted with **<X>**.

4.3.7 Detail points

With the function ***Calculate > Detail Points***, surveyed points orthogonal to a measured line can be transformed into coordinates of the current system and the other way round. For this purpose, the submenus ***Detail Points*** and ***Transformation on Ref.Line*** are available.

If a line has not yet been defined, the input dialog for the measured line appears first of all. Here, the starting and end point numbers as well as their local coordinates can be entered. The following rules apply to such an input:

- If a Y-field is unoccupied, it is assumed to be 0.
- If an X-field is unoccupied, it is computed.
- If both X-fields are unoccupied, the first is assumed to be 0 and the second is calculated.

The local magnitudes are reduced prior to the detail point calculation.

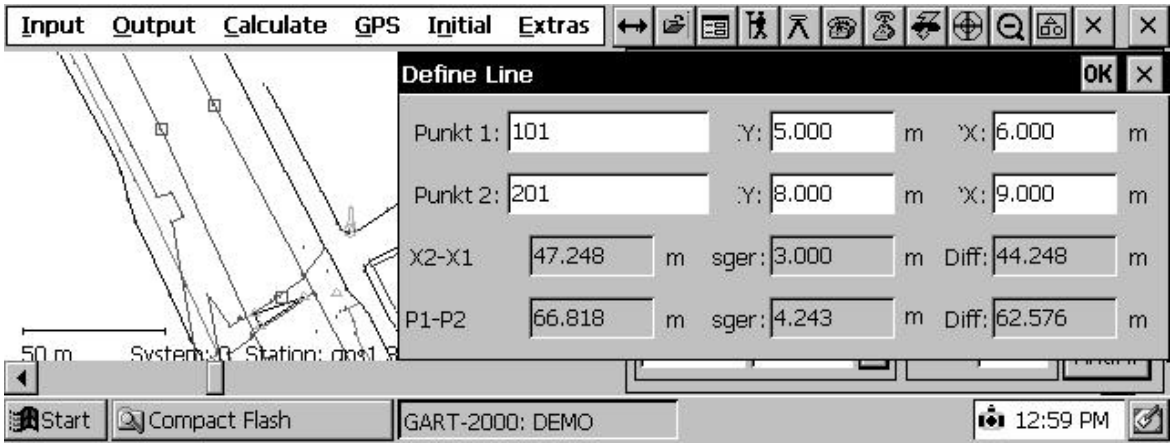

Input Output Calculate GPS Initial Extras
Define Line
OK
Punkt 1: 101 Y: 5.000 m X: 6.000 m
Punkt 2: 201 Y: 8.000 m X: 9.000 m
X2-X1 47.248 m sger: 3.000 m Diff: 44.248 m
P1-P2 66.818 m sger: 4.243 m Diff: 62.576 m
50 m
Start
Compact Flash
GART-2000: DEMO
12:59 PM

Figure 4-115: Define Line

4.3.7.1 Detail Points

In the submenu ***Detail Point*** you can enter the surveyed detail points with their ordinates and abscissa.

During input of the coordinates, the point is represented in the graphic. When the input has been confirmed with **<OK>**, the dialog for saving coordinates is called up and point number and code can be entered.

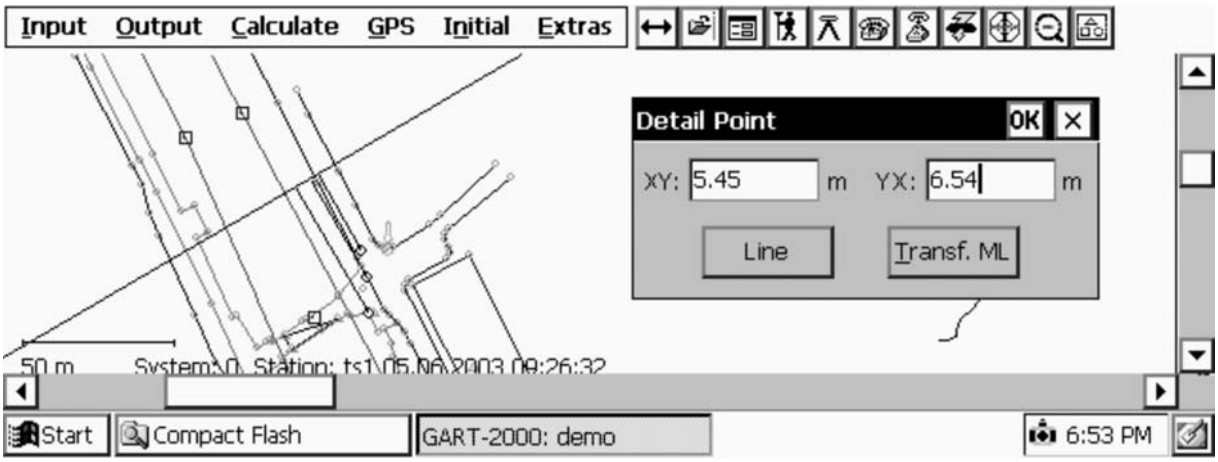


Figure 4-116: Input of planar coordinates in system of measurement

By pressing the button **<Line>,** a new measured line can be defined so that a new detail point measurement can be entered. With the button **<Transf. ML>** you can change to ***Transformation on Measured Line*** at any time.

4.3.7.2 Transformation on Measured Line

The function ***Transformation on Measured Line*** calculates the detail point magnitudes of a point with reference to a measured line. To this end, when a measured line has been defined, it is only necessary to select a point in the graphic or enter it in the field **PtNr**. The detail point magnitudes **X** and **Y** as well as the coordinates of the foot point are then represented in the dialog.

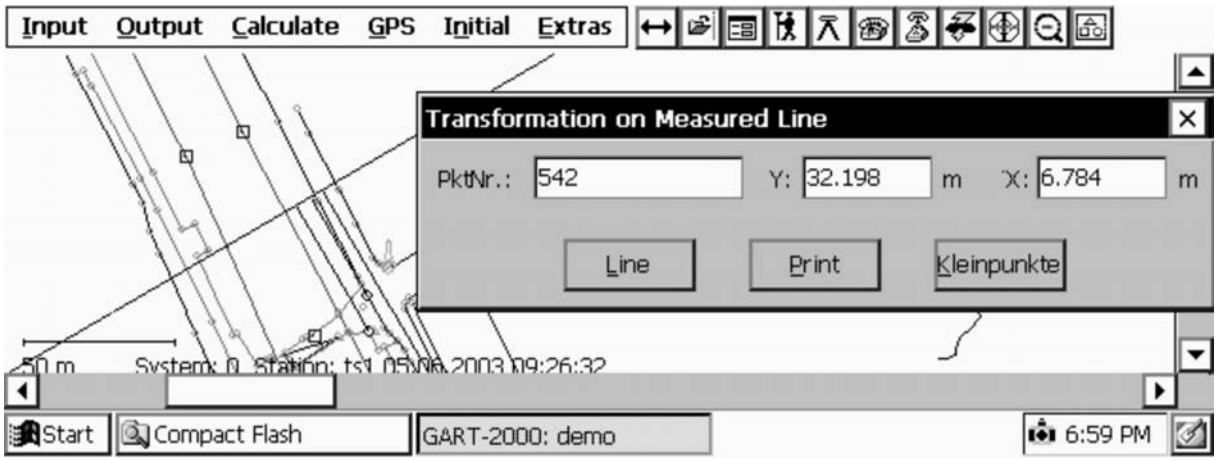


Figure 4-117: Transformation on Measured Line

The result of the calculation can be protocolled by clicking the button **<Print>**. A new measured line can be defined by pressing the button **<Line>**. To switch to the Detail points, press the button **<Detail Points/Kleinpunkte>**.

The graphic enables a visual control of the calculations.

4.3.7.3 3D Detailpoints

Using the function ***Calculate > Detail points > 3D Detail points*** detail points are calculated

spatially. The reference level is laid through the starting and end point of the measured line, so that the Y-axis and X-axis are parallel.

Transformation on measured line

The points to be transformed are transformed to the “plane of the measured line” during the calculation of 3D detail points.

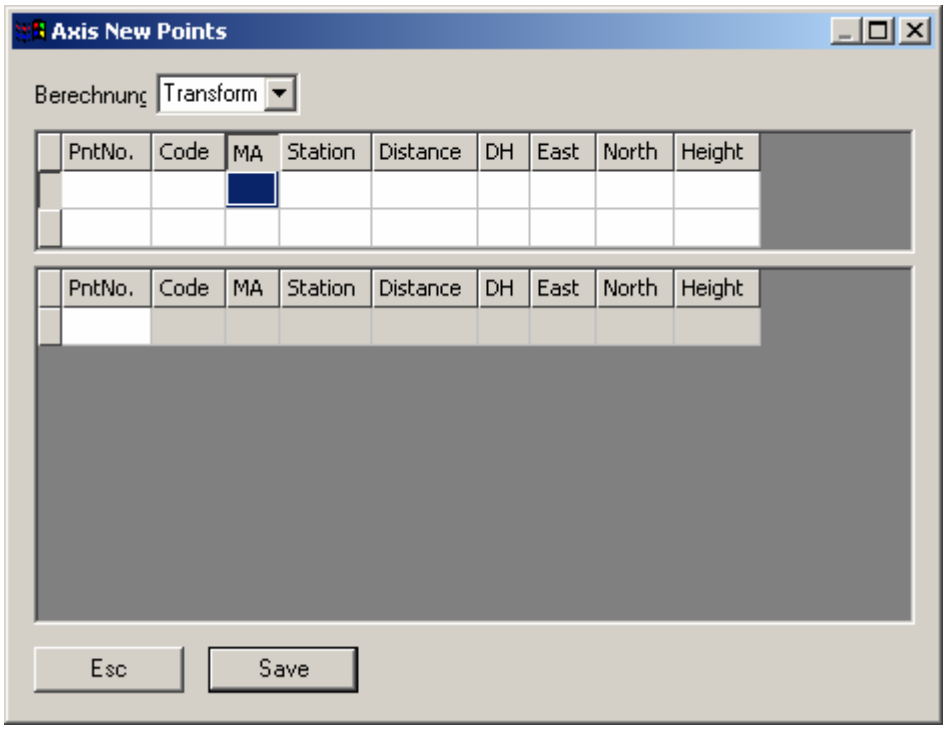


Figure 4-118: Axis New Points

With the **<Save>** button the transformed points are recorded.

4.3.8 Instrument Errors

The function ***Calculate > Instrument errors*** serves to determine the instrument errors of a total station. When the function is called up, the instrument for which the error determination is to be carried out is queried first of all. Subsequently, the measurements take place in the following order:

1. Target Face 1 (horizontal sight)
1. Target Face 2 (horizontal sight)
2. Target Face 1 (steep sight)
2. Target Face 2 (steep sight)

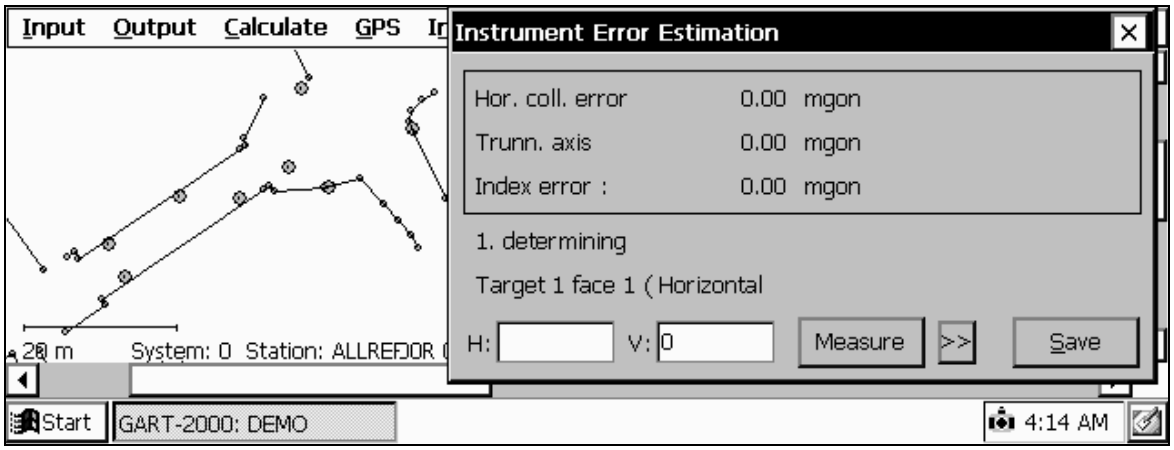


Figure 4-119: Dialog for determining instrument errors

The measurement is triggered by the button **<Measure>**. The angles are displayed in the fields **H** and **V**. By pressing the button **<Save>**, the measured values are accepted. The same procedure occurs for the other settings. After each measurement the errors to be determined are recalculated and displayed. The button **>>** enables remote control in the case of servo-driven instruments.

The dialog is quitted with the button **<X>**. The user is then asked if the instrument errors determined are to be adopted.

4.3.9 Transformation

With the function ***Calculate > System Transformation*** the surveyed points or coordinates can be transformed from one coordinate system into another existing system (see ***Initial > System***) via identical points. After clicking the menu item, a dialog box appears in which the destination system is selected.

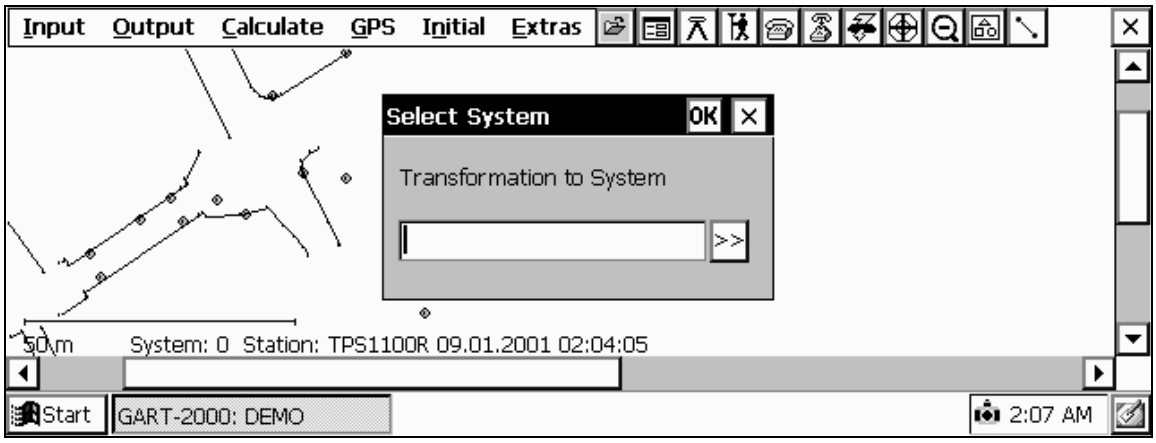


Figure 4-120: Selection of destination system

After selection of the destination system, the points in the source system are displayed.

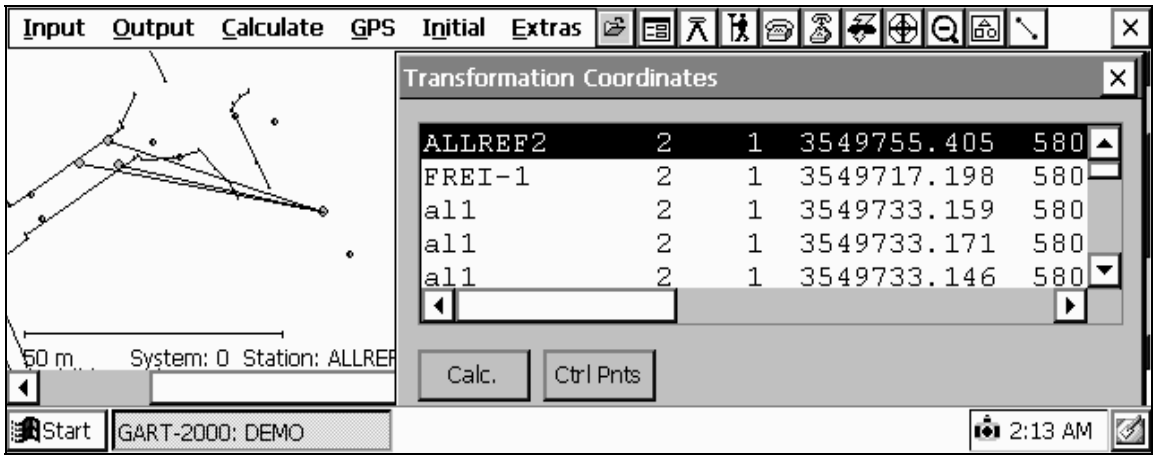


Figure 4-121: Transformation Coordinates

By clicking the button **<Ctrl Pnts>**, the existing control points (identical points in both systems) automatically identified by ***GART-2000® CE*** can be displayed. With **<Enter>** or **<Delete>** the list of control points can be modified.

Depending on the selected type of transformation, two or three control points are required. If an insufficient number of control points is available to calculate the transformation parameters, a corresponding error message pops up in ***GART-2000® CE***.

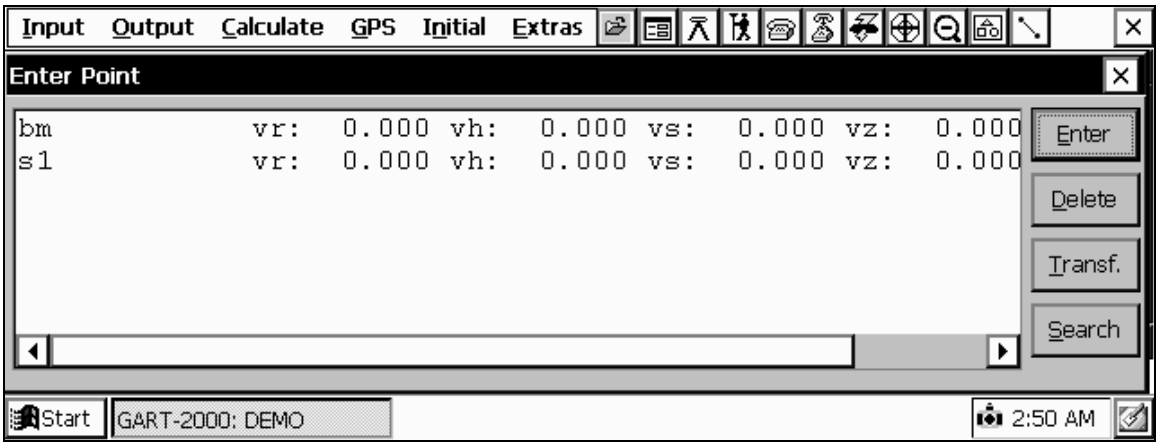


Figure 4-122: Control Points

The transformation type can be fixed by clicking the button **<Transf.>**. The 3-Parameter Transformation is used in **GART-2000® CE** as standard. However, the following transformation types are also available:

- **3-Parameter Transformation:** the scale factor m is set to 1, calculations comprise the displacements in the x- and y-direction as well as the angle of rotation j of the coordinate system.
- **4-Parameter Transformation:** the scale factor m is calculated in addition to the 3-Parameter Transformation.
- **5-Parameter Transformation:** in contrast to the 4-Parameter-Transformation, a uniform scale factor m is not determined, but rather the respective scale factors m_x and m_y for each coordinate axis.
- **6-Parameter Transformation:** in contrast to the 5-Parameter Transformation, not only a rotational angle is calculated, but also a separate angle of rotation for each coordinate axis (shearing, the rectangularity is abandoned).

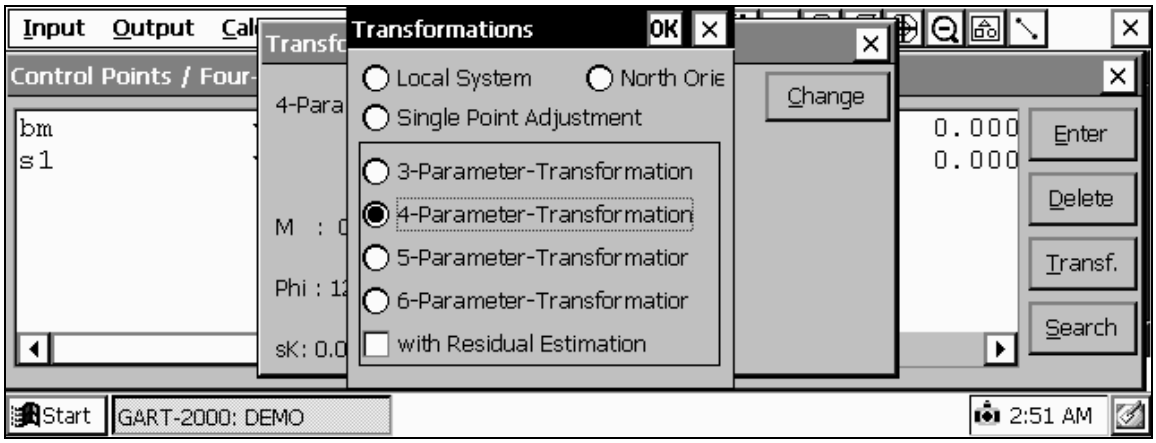


Figure 4-123: Selection of transformation method

The respective transformations can be calculated with or without residual estimation. In the residual estimation, a coordinate adjustment with neighborhood in-fitting takes place, i.e. the control points are mapped onto themselves. The elevations of the points in the destination system are calculated from the mean height difference of the control points.

After the transformation parameters have been calculated, these are displayed in a dialog box.

If an adequate number of control points have been specified in the control point dialog, this can be quitted via the **<X>** button. The user is returned to the transformation dialog. After pressing the button **<Calculate>**, the transformation is performed as soon as the point range to be transformed is specified.

The transformation dialog is quitted with **<X>**.

The transformed coordinates can be examined via the menu ***Output > Coordinates*** after a change of current system (***Initial > System***).

4.3.10 Traverse

The menu item ***Calculate > Traverse*** serves to calculate traverses on the basis of already conducted surveys. This means that, prior to defining and calculating the traverse, one must have registered the measurement values on all break points and backsight points (see menu item ***Input***).

With ***GART-2000® CE*** a total of four different kinds of traverses can be calculated, whereby the respective type is automatically determined by the program:

Traverse linked on both sides: all four points PAR, PA, PE and PER must be specified. ***GART-2000® CE*** initially calculates the longitudinal and transverse deviation. The calculation of coordinates is carried out by means of transformation via both connecting control points.

Closed-figure traverse (without orientation): only the points PA and PE need to be specified. The traverse is calculated between the two connecting points.

Traverse linked on one side: this only requires the first point PA and the first connecting control point PAR to be specified. No closure error (misclosure) can be calculated with this kind of traverse. All traverse points are ultimately attached one after the other using polar measurements.

Ring traverse: the calculation of a ring traverse principally requires the same input as a traverse linked on both sides. However, the starting and end point (PA and PE) coincide. The

calculation is carried out after the angular closure error has been distributed evenly among the break points. The coordinate inconsistencies are distributed in proportion to the distance.

Combined forms of these four types of traverse can be calculated; ***GART-2000® CE*** examines the plausibility of the values entered and produces a corresponding error message if the traverse is not calculable.

4.3.10.1 Traverse

The function ***Calculate > Traverse >Travers*** in ***GART-2000® CE*** opens up the relevant dialog window. This is where the control points are entered, depending on the kind of traverse (PA, PAR, PE, PER). The points can be selected by simply clicking them in the graphic or can be manually entered. The abbreviations denote the following:

Name	Point name
Code	Point number of the starting point of the traverse
PAR	Point number of the connecting direction of the traverse
PE	Point number of the end point of the traverse
PER	Point number of the closing direction of the traverse

The break points are entered with **<Enter>**. After this button has been clicked, the point input dialog appears, where the break points must be entered in the relevant order. If a point is to subsequently included, the marker is placed at the relevant position in the list of break points and the point is inserted in the list by clicking the button **<Enter>**. After the input of points is completed, erroneous entries can be removed with **<Delete>**. A new traverse can be defined with **<New>**.

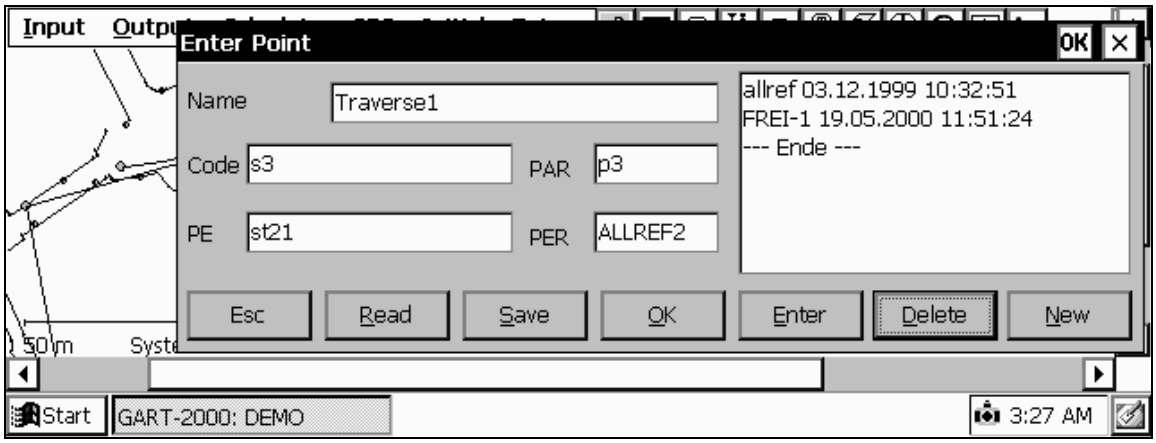


Figure 4-124: Traverse definition

Following definition of the traverse, it can be saved by clicking the button **<Save>**. Via the button **<Read>** traverses saved in this way can be recalled at a later stage. The calculation of the defined traverse is executed by clicking the button **<OK>**.

In the output window that then opens up, the traverse type automatically determined by ***GART-2000® CE*** is displayed, along with the number of break points and the total length of the traverse. The values ***"FW"***, ***"FL"*** and ***"FQ"*** provide information on the closure error that has been computed, which is also compared with the official error/accuracy limits stipulated in Germany by the respective state authorities.

The results of the calculation can be saved by clicking the button **<Save>**. Via the button **<Esc>** the window can be closed without saving the coordinates calculated. The measurement values from the traverse can optionally be displayed by clicking the corresponding buttons.

4.3.10.2 Traverse manual (only in GART-2000® NT and Viewer)

The function ***Calculate > Traverse > Traverse manual*** opens the corresponding dialog window. This function resembles the function described under 4.3.8.1. Though, the angle of refraction and the distance to the starting and/or end point can be entered manually.

4.3.11 Continuous Control Measurements

Using Calculate > Continuous Control Measurements the continuous control measurements of a polygon are indicated.

The points can be selected in the graphic or entered by the keyboard.

Explanation of various buttons:

<Cancel>	By pressing the <Cancel> button the function is cancelled.
<OK>	By pressing the <OK> button the input of point numbers can be confirmed. Thus, the missing elements are calculated.
<Delete>	By pressing the <Delete> button a selected raw can be deleted.
<Input>	By pressing the <Insert> button an empty raw can be inserted before a selected raw.
<Output>	By pressing the <Output> button the calculation is recorded into the log-file defined under **Initial > Protocol**

4.3.12 Parallel Offset

With the menu function ***Calculate > Parallel Offset*** a polygon which was shifted parallel is calculated.

To parallel-shift a polygon enter a value in the field **<Offset>**.

If coordinates already exist in the list, the shifted polygon is calculated and drawn using the input or change of the entered offset. The polygon points can be selected by clicking within the graphic or by using the keyboard. If the value to be shifted is already entered in the **<Offset>** field, the polygon is calculated and displayed within the graphic.

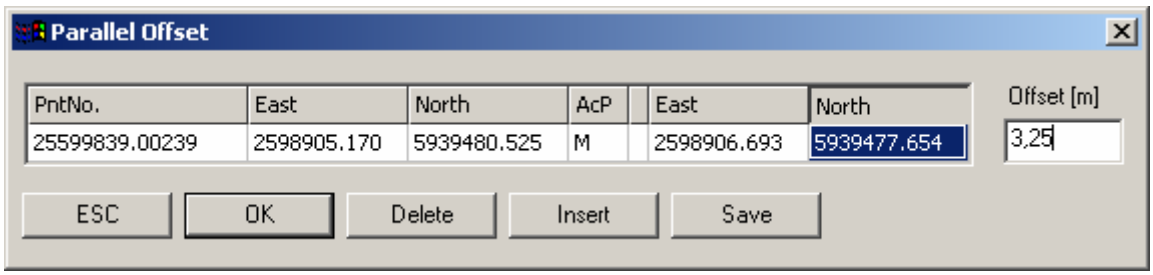


Figure 4-125: Parallel Offset

Explanation of various buttons:

<ESC>	By pressing the <Esc> button the function is cancelled.
<Delete>	By pressing the <Delete> button a selected raw can be deleted.
<Insert>	By pressing the <Insert> button an empty raw can be inserted before a selected raw.
<OK>	By pressing the <OK> button the input of point numbers can be confirmed using the keyboard. Thus, the polygon to be shifted is calculated and displayed in the graphic.

Subject to the correlating position of the points and to the angle between the single lines the shifted polygon can have less breakpoints than the original polygon. In this example the points 89-00237 and 89-00238 were chosen as the points to be shifted parallel. In this case, the calculated new polygon has only one breakpoint!

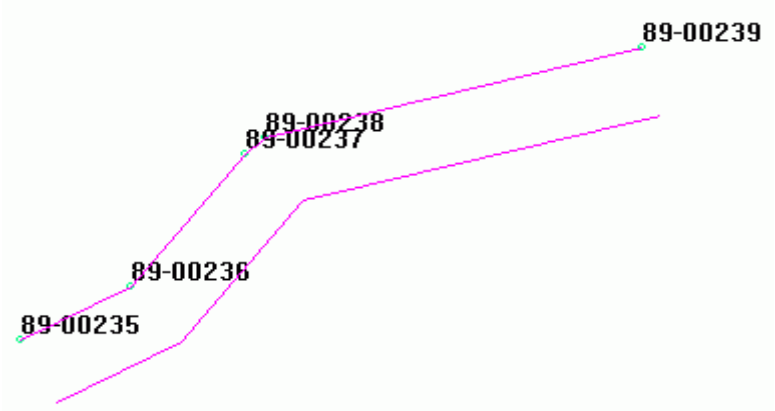


Figure 4-126: Outline

The several breakpoints of the shifted polygon can be stored by pressing the **<Save>** button.

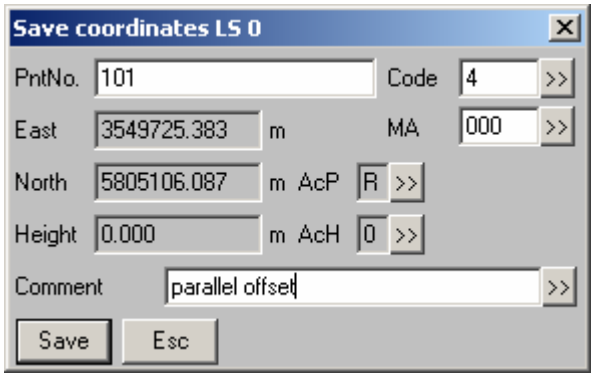


Figure 4-127: Save coordinates

4.4 GPS-Menu

The initialisation of the GPS-receiver is carried out with the ***GPS*** menu.

4.4.1 Find

The button shown above starts the ***GPS > Find*** menu. The current position of the GPS rover is displayed with a marker in the center of the graphic screen.

4.4.2 Start Base

The initialisation of the Base station is done with the ***GPS > Start Base*** menu or the button shown above.

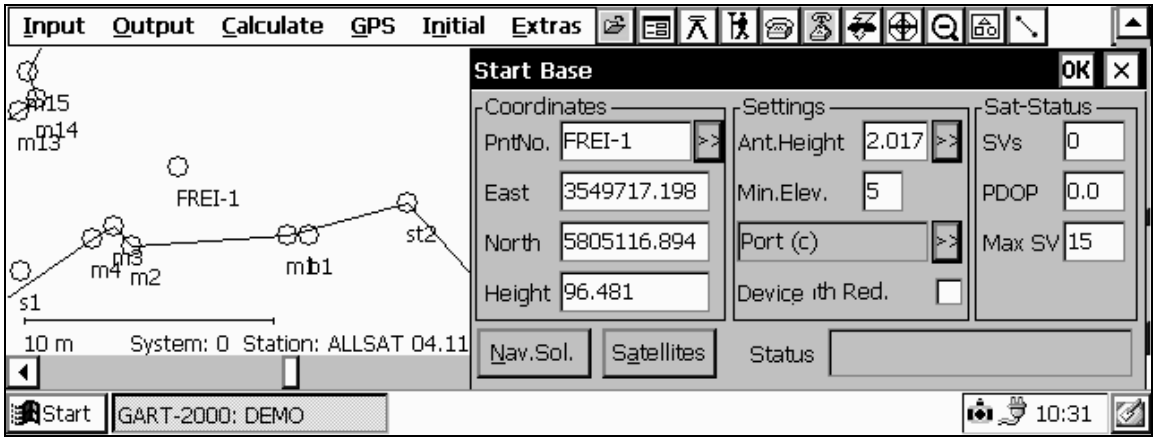


Figure 4-128: Start Base (Topcon)

The individual fields vary according to the type of receiver and have the following meaning:

PntNo.	Point number of the base station. The reference coordinate is stored with this number in ***GART-2000® CE***.
East	East of the base station in the user system [m]
North	North of the base station in the user system [m]
Height	Height of the base station in the user system [m]
Ant.Height	True vertical antenna height (marker to phase center of antenna) [m]
Min.Elev.	Minimum elevation mask - the base receiver will only transmit differential corrections for satellites with elevations above the minimum elevation mask [°]
Port	Port identifier for the differential corrections (radio or cell phone (GSM) port)
Multipath Red.	Multipath Reduction. When activated, an additional algorithm is applied to reduce the multipath influence. (Only for Topcon)
SVs	Number of satellites that are used for the position calculation - this field will be empty unless a navigation solution is queried from GPS receiver
PDOP	Current PDOP value - this field will be empty unless a navigation solution is queried from GPS receiver
Max SV	Maximum number of satellites to be included in corrections (JNS only;

0 = all available)

Multi-Base Multi-Base option. When activated, you can transmit correction data on your base station via several radio ports.

The button **<Sat>** shows the available satellites if ***GART-2000® CE*** is able to establish a connection to the GPS receiver.

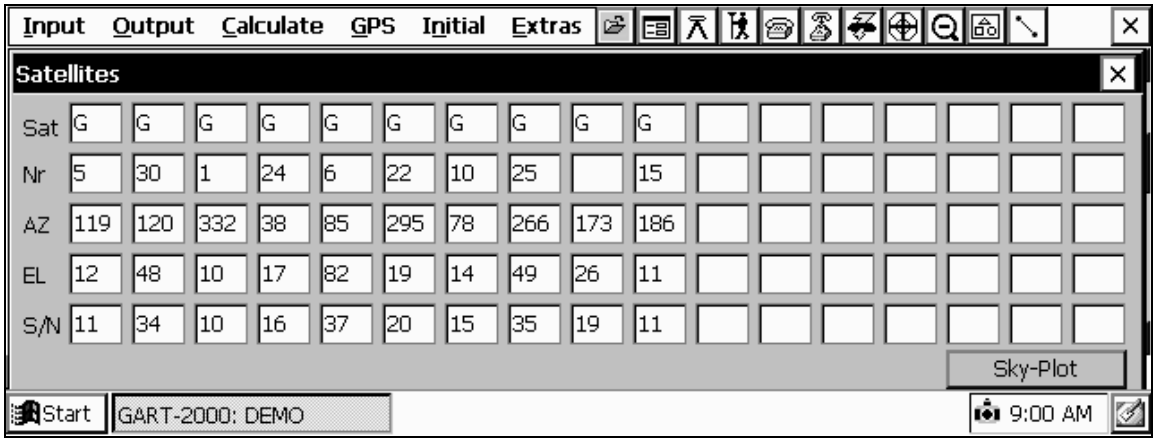


Figure 4-129: Satellite Overview

The satellite overview displays the satellite number, the azimuth, the elevation and the signal/noise-ratio of the different satellites on the screen.

For Topcon-receivers the GPS satellites are marked with a ***'G'***, GLONASS satellites with a ***'R'*** in the first row.

For Ashtech receivers, in addition, you will see a flag (***'-'*** or ***'U'***). The satellites are marked with a ***'U'*** if differential corrections exist for a satellite. Otherwise, a ***'-'*** is shown.

The button **<Sky-Plot>** shows the actual geometry of satellites on screen.

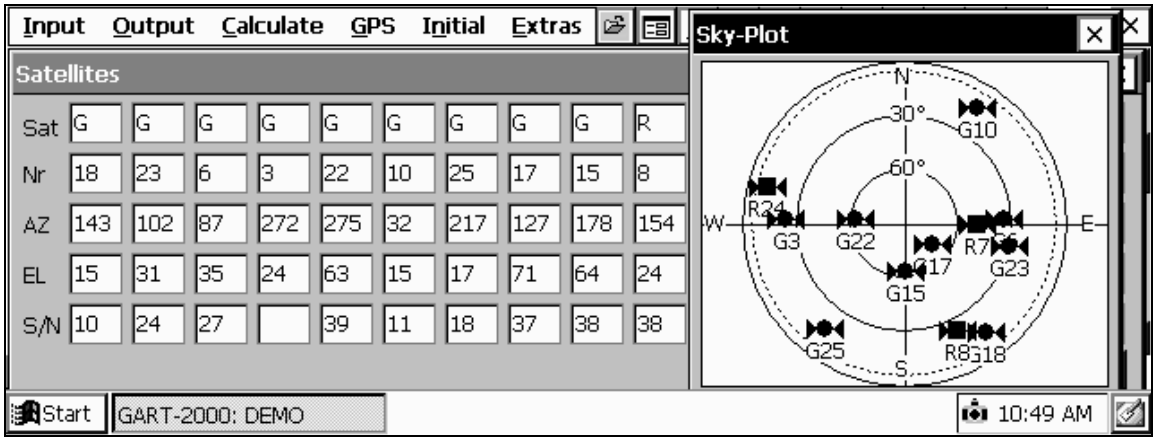


Figure 4-130: Satellite geometry in Sky Plot

The button **<Nav Sol.>** reads a position from the navigation solution of the receiver if the receiver tracks four or more satellites.

Furthermore for Topcon receivers the maximal number of used satellites can be chosen and the **Multipath Reduction** can be activated. Therefore the Base- and the Rover-receiver need to have the necessary option. The multipath settings should be the same for base and rover receiver.

Should you wish to use your Topcon receiver as a reference station serving several mobile receivers simultaneously, the option **<Port>** should be activated.

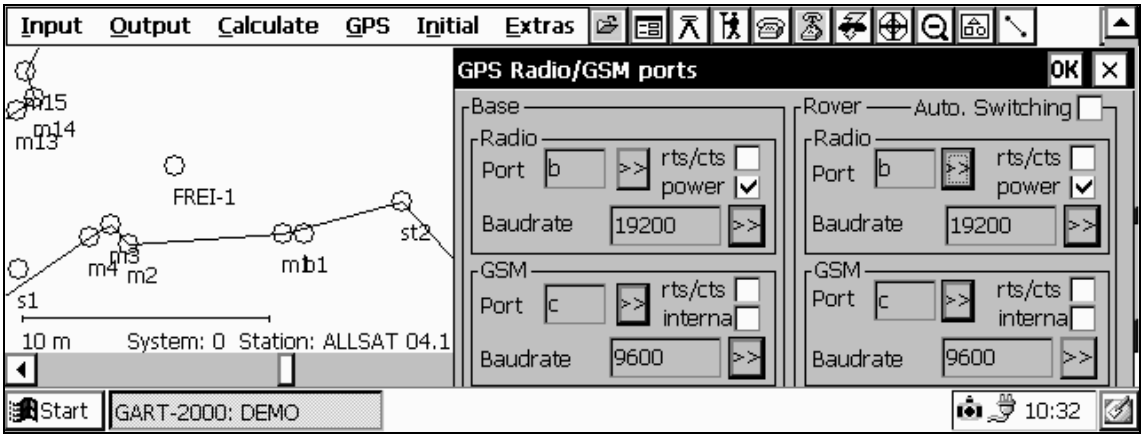


Figure 4-131: GPS Radio port

The port to which the correction data are to be sent from the base can be selected in this dialogue.

The choice of the baudrate determines the data transfer speed with the radio or GSM modem. The GPS receiver is set to this baudrate during the initialization of the mobile receiver.

When the **<power>** checkbox is activated, the radio modem is supplied with electricity from the receiver.

The **<internal>** checkbox must be selected when the GSM modem is integrated in the GPS receiver (e.g. in the Hiper from Topcon).

After having done all settings the button **<OK>** initialises the Base receiver and saves the reference coordinates.

The button **>>** next to the field **Ant.Height** opens the submenu for the antenna height. Choose the manufacturer and the antenna type. For each antenna type the individual antenna offsets are shown.

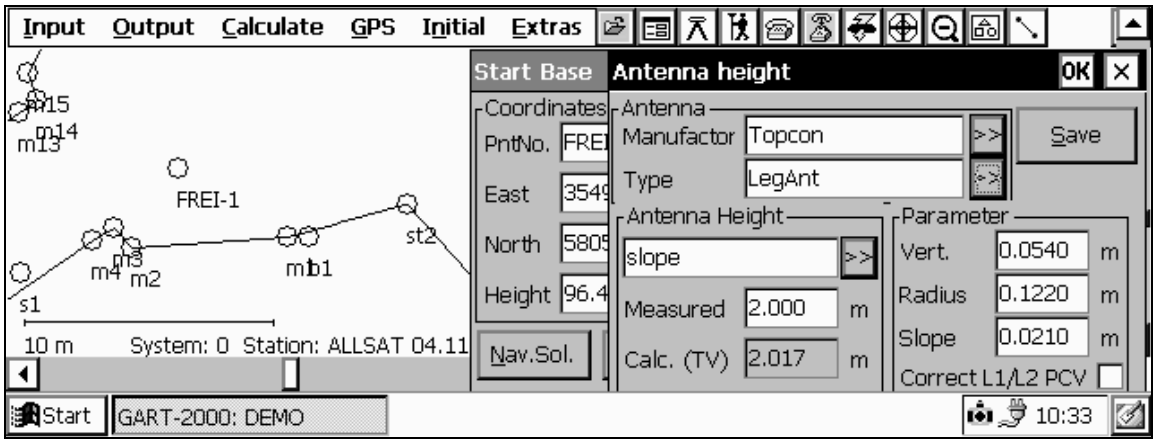


Figure 4-132: Antenna Height

Enter the type of antenna height measurement:

"instrument height": measured from the marker to the bottom of the antenna at the base of the mounting threads,

"slope": measured from the marker to the lower edge of the groove around the antenna at the seam between the top and bottom halves of the antenna casing.

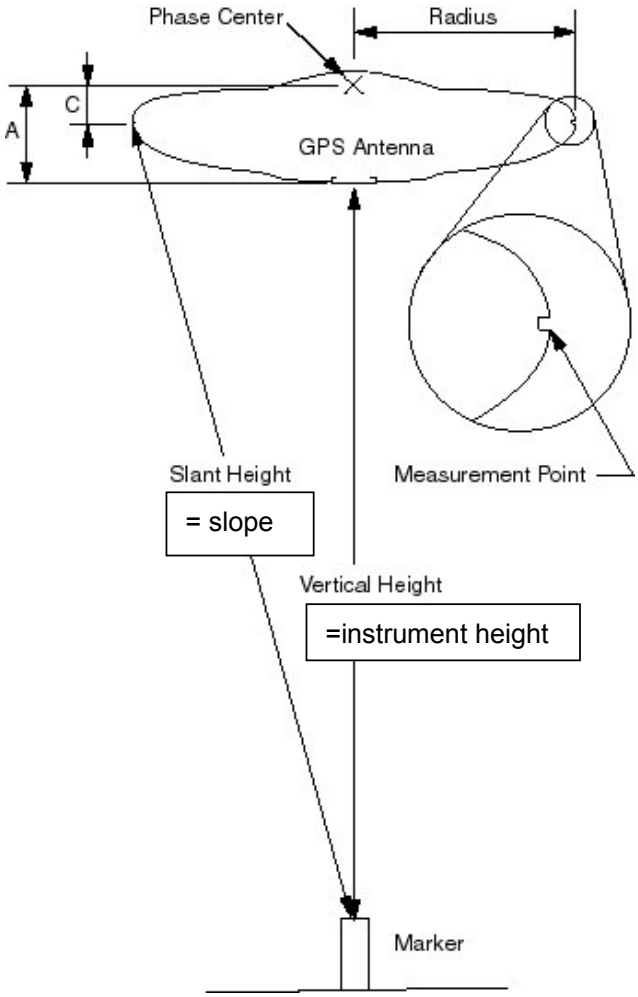


Figure 4-133: Antenna height measurement (from Topcon)

In the field **Measured** enter your slope or vertical antenna height. The true vertical height will be calculated immediately and will be shown in the field **Calc (TV)**. After leaving this window with the **<OK>** button, the true vertical height will be set as antenna height in the measurement window.

By activating the checkbox <Correct L1/L2 PCV>, the offsets between L1 and L2 of the antenna phase center (North, East, Height) are sent to the reference station for the respective antenna type.

The true vertical antenna height in ***GART-2000® CE*** allows for different antenna offsets in the case of different antenna types being used on base and rover. In addition to the predefined antenna types in the list, you may enter your own antenna types. To do so enter a new name for your antenna and edit the values in the offset fields. The button **<Save>** stores the new entry.

If you have selected the correction data format ***"Standard NMEA"***, the function ***GPS > Start Base*** is deactivated.

4.4.3 Start Rover

The initialisation of the Rover receiver is done with the ***GPS > Start Rover*** submenu or with the button shown above.

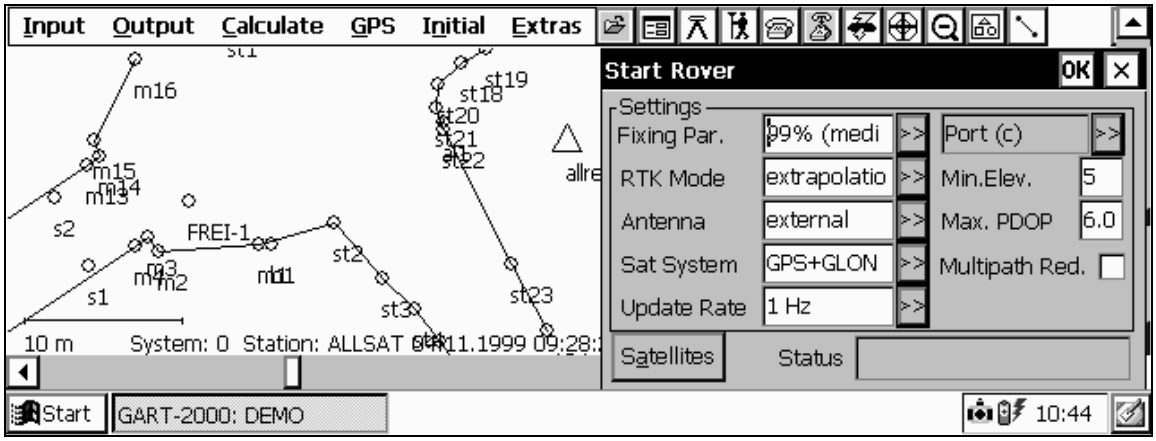


Figure 4-134: Start Rover (Topcon)

Different settings can be chosen (vary with the used receiver type):

Fixing Par.	This value has an effect on the reliability for the ambiguity fixing. For more information see below in this chapter.
Port	Select the input-port for the differential corrections via radio or cell phone (GSM) modem. Chose between A, B, C, and D. Default is port C. (see Figure 4-105)
Min. Elev.	Elevation cutoff. Satellites below this elevation will not be used for position calculation.
Max. PDOP	Threshold value for controlling PDOP. If a measurement with a PDOP higher than this value is stored, ***GART-2000® CE*** displays a warning message. Nevertheless the measurement may be saved.

For Topcon-receivers you can choose the **<RTK-Mode>** (extrapolation or delay), the **<Antenna>** (internal, external or automatic), the **<Sat System>** (GPS or GPS&GLONASS), the **<Update Rate>** (1 Hz and 2 Hz) and optionally activate the **Multipath Reduction**.

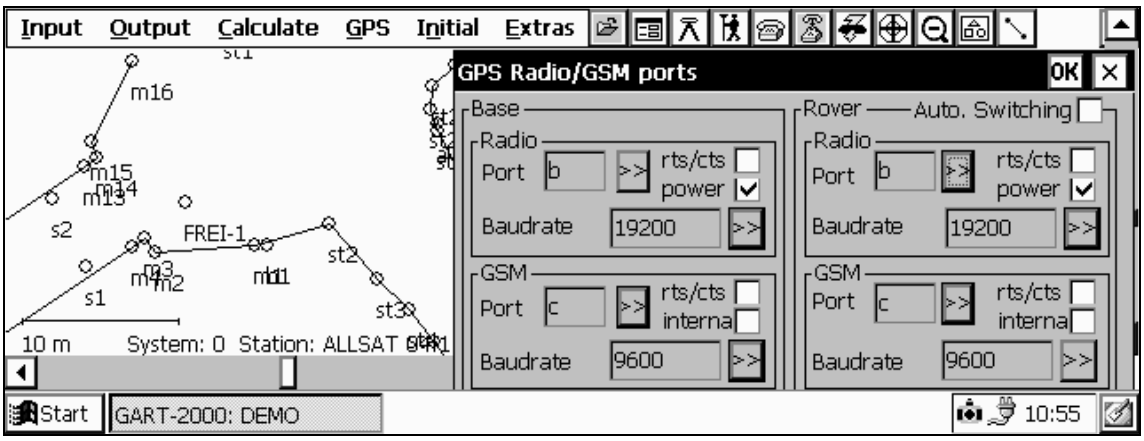


Figure 4-135: GPS Radio port

The choice of the baudrate determines the data transfer speed with the radio or GSM modem. The GPS receiver is set to this baudrate during the initialization of the mobile receiver.

When the **<power>** checkbox is activated, the radio modem is supplied with electricity from the receiver.

The **<internal>** checkbox must be selected when the GSM modem is integrated in the GPS receiver (e.g. in the Hiper from Topcon).

When radio and GSM communication is used, the function **<Auto. Switching>** can be activated at the rover. As soon as a GSM connection has been successfully established, the use of the radio port is switched to the GSM port and, when the connection has been terminated, the radio port is re-activated.

The **<OK>** button saves your entries and returns you to the previous window.

The **RTK-mode** can be set to ***"extrapolation"*** or ***"delay"***. **Extrapolation** decreases the latency of the position and can extrapolate through short radio outages. **Delay** is more accurate and is the normal mode for RTK surveying of fixed points.

The fixing parameter defines the confidence interval for the ambiguity fixing:

confidence interval	fixing parameter Ashtech	fixing parameter Topcon
no ambiguity fixing	float	float
90 %	very low	--
95 %	low	low
99 %	medium	medium (default)
99,9 %	high (default)	high
99,99 %	very high	--

A confidence interval of 99.9% means that statistically one out of thousand ambiguity fixings is wrong.

The mode **high** stands for the most reliable ambiguity fixing, but takes most time. The mode **low** is the fastest, but there is a higher possibility of a wrong ambiguity fixing. The value **high** is recommended for most static or kinematic applications. The mode **float** means that the receiver will not try to fix the ambiguities. This feature works only with Ashtech GG24 or with Topcon receivers.

Use the **<OK>**-button to initialise the Rover receiver. Be sure of having chosen the correct settings in the submenu ***Initial > Constants > GPS*** because these settings affect the Rover initialisation.

The button **<Sat>** shows the available satellites if ***GART-2000® CE*** is able to establish a connection to the GPS receiver.

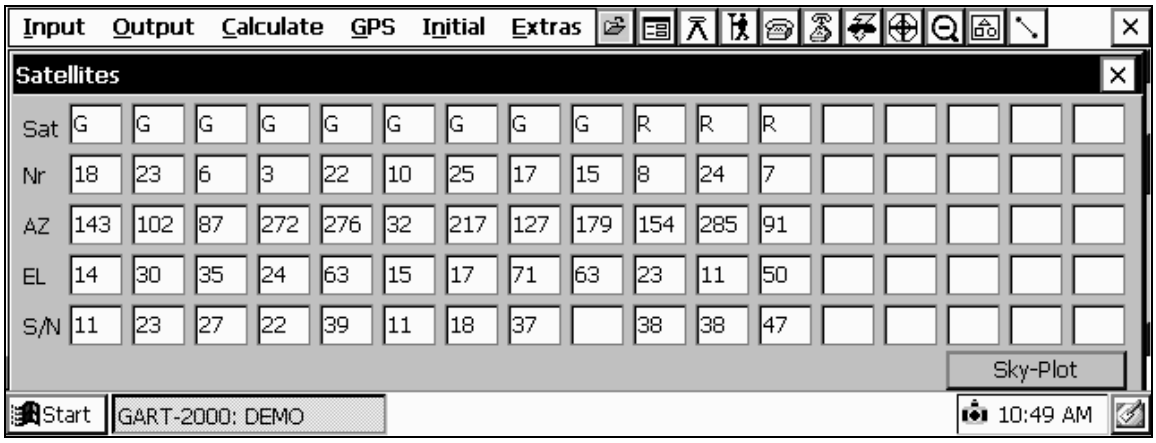


Figure 4-136: Satellite Overview

The satellite overview displays the satellite number, the azimuth, the elevation and the signal/noise-ratio of the received satellites.

For Topcon-receivers the GPS satellites are marked with a ***'G'***, GLONASS satellites with a ***'R'*** in the first row.

For Ashtech receivers there is an additional flag (***'-'*** or ***'U'***). The satellites are marked with a ***'U'*** if differential corrections exist for a satellite. Otherwise, a '**-**' is shown.

The button **<Sky-Plot>** shows the actual geometry of satellites on screen.

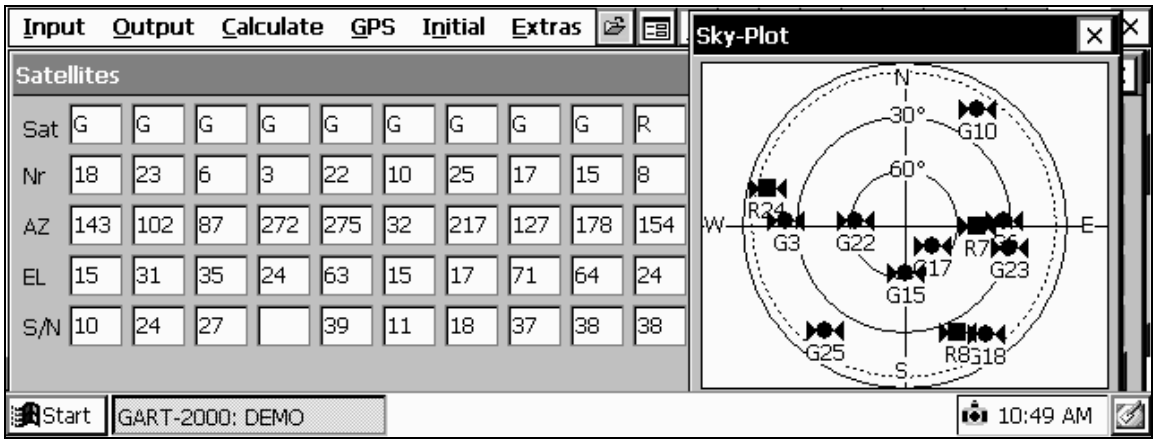


Figure 4-137: Satellite Geometry in Sky Plot

Using the differential correction format ***"Standard NMEA"*** there will be another dialog when using the menu ***GPS > Start Rover***:

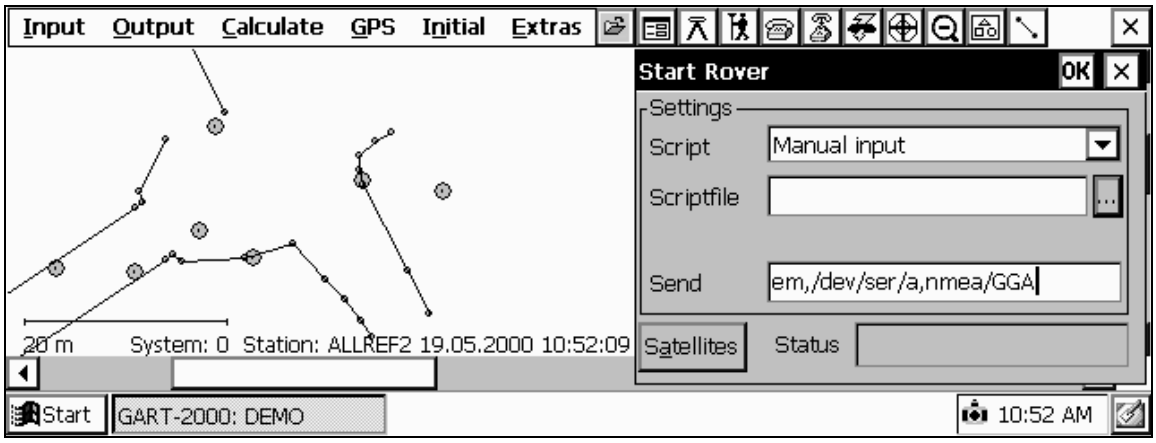


Figure 4-138: Start Rover (Standard NMEA)

The field **Script** offers three different possibilities to initialise the Rover receiver:

"No Script": Use this kind of initialisation, if the Rover receiver automatically sends data and must not be initialised with any commands.

"Manual Input": There may be entered separate commands into the field ***Send*** to initialize the Rover receiver.

"File": Load a scriptfile with several commands to initialize the Rover receiver. Use the button **<...>** next to the field **Scriptfile** to select the file.

The button **<Sat>** shows the available satellites if ***GART-2000® CE*** is able to establish a connection to the GPS receiver.

Use the **<OK>**-button to initialize the Rover receiver or to send a command.

The following NMEA messages are currently supported by ***GART-2000® CE***: GGA, GSV and GST.

4.4.4 Static Recording

With ***GPS > Static Recording*** rawdata can be logged in the internal memory of your receiver.

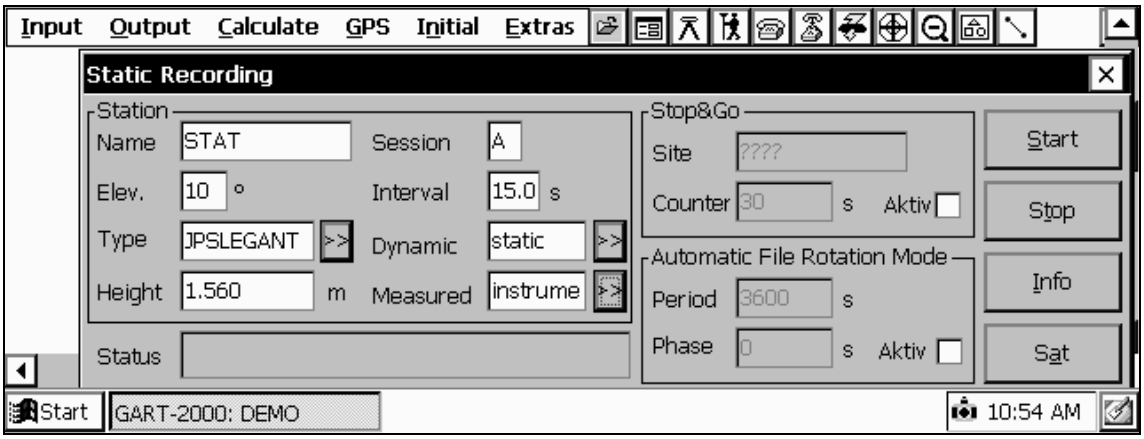


Figure 4-139: Static Recording (Topcon)

The meanings of the different fields are as follows:

Name Any name for the station (Ashtech: max. 4 characters; Topcon: max. 16 characters), which will also be part of the name of the rawdata-file.

Elev. Elevation mask. Rawdata are only stored from satellites that are above this elevation angle.

Type The antenna type: the name of the GPS- or GPS&GLONASS-antenna. The choice of the right antenna impacts the calculation of the correct antenna height. (See also Figure 4-110)

Height Height of the antenna's phase center above the ground point in meters. For Topcon receivers the slope or vertical antenna height can be entered. For Ashtech receivers the button **>>** next to the field **Ant.Typ** opens the standard antenna menu.

Session Name of the session

Interval Recording interval in seconds

Dynamic Dynamic of receiver. You can choose between walking and static.

Measured Method of height Measurement. The possible choices here are: ***"Vertical"***: height of a prism rod up to the antenna thread. ***"Oblique"***: oblique distance from the ground to the mark on the antenna. (See Figure 4-110 for further explication.)

The parameters <Type> to <Measured> will be added as 'event' to the Topcon-file.

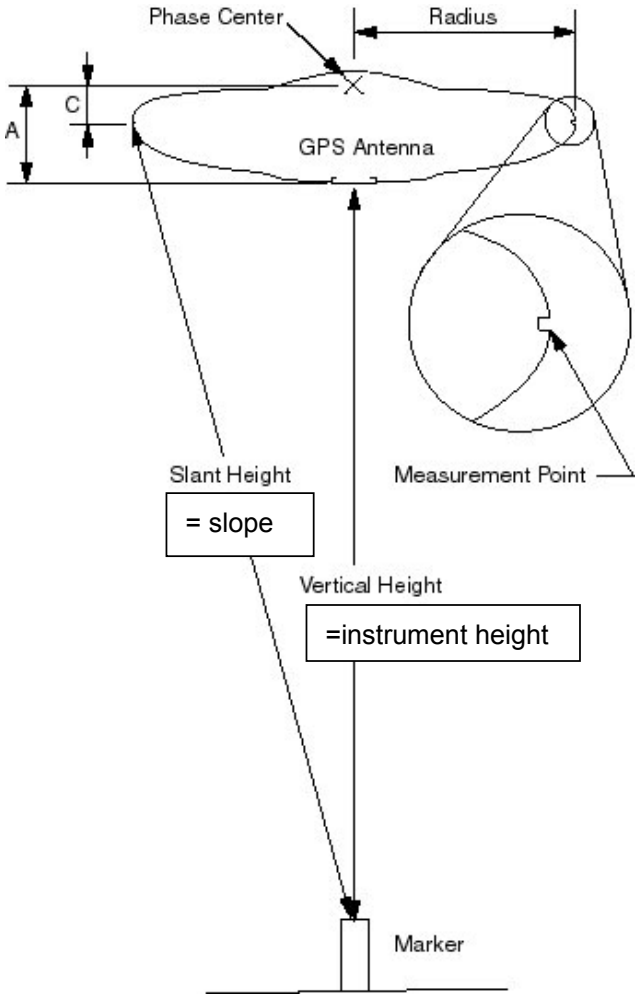


Figure 4-140: Antenna height measuring (from Topcon)

The button **<Start>** starts raw data recording on receiver.

To end session, click **<Stop>** button.

With the button **<Info>** the content of memory can be checked.

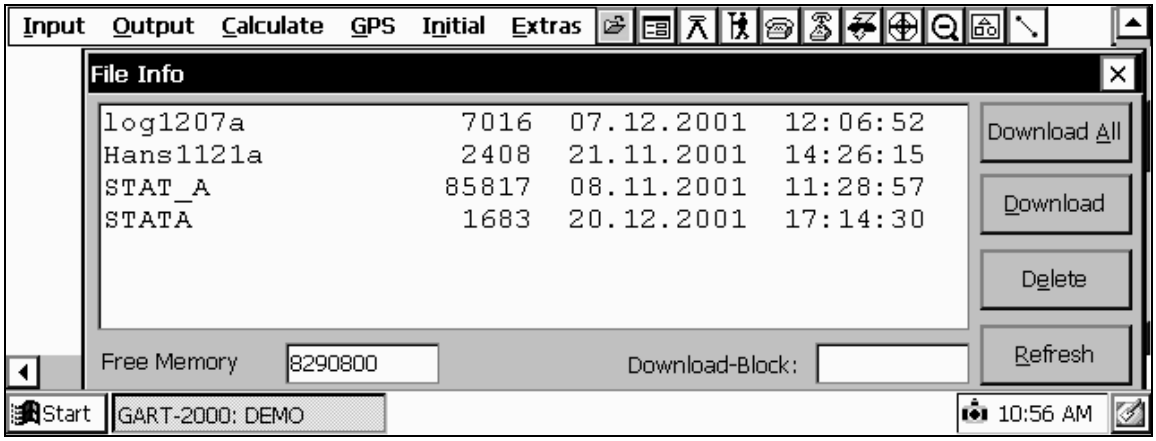


Figure 4-141: Content of memory

This window displays the name of the raw data file and its size in kilobytes, the available free memory in the receiver in kilobytes, as well as the date and GPS time of the recording. With the buttons **<Download All>** or **<Download>** you can transfer the files from the receiver to the field computer. By pressing the button **<Delete>**, you can erase a raw data file that you have previously highlighted from receiver memory. The display is updated by pressing **<Refresh>**. The **<X>** key brings you back to the previous window.

The button **<Sat>** shows the available satellites if ***GART-2000® CE*** is able to establish a connection to the GPS receiver.

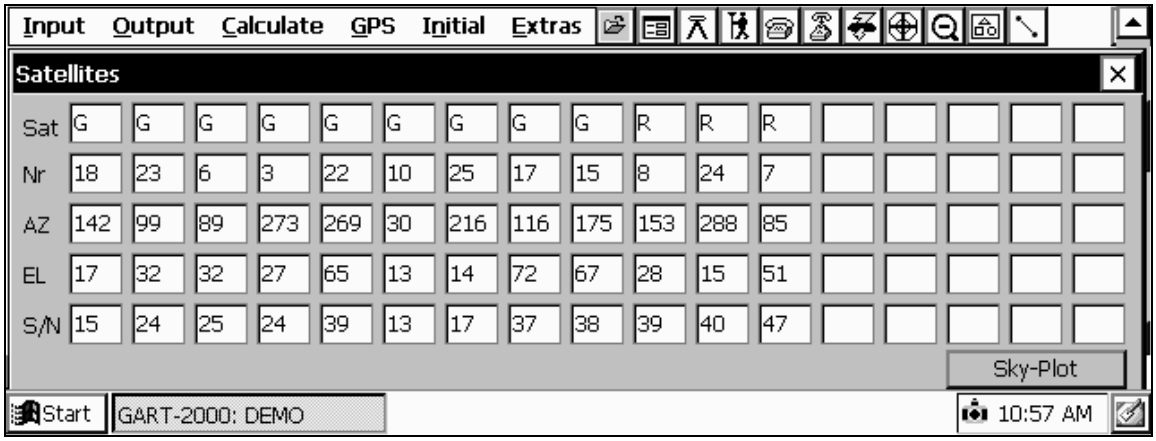


Figure 4-142: Satellite Overview

The satellite overview displays the satellite number, the azimuth, the elevation and the signal/noise-ratio of the different satellites on the screen.

For JNS-receivers the GPS satellites are marked with a ***'G'***, GLONASS satellites with a ***'R'*** in the first row.

For Ashtech receivers, in addition, you will also see a flag (***'-'*** or ***'U'***). The satellites are marked with a ***'U'*** if differential corrections exist for a satellite. Otherwise, a '**-**' is shown.

The button **<Sky-Plot>** shows the actual geometry of satellites on screen.

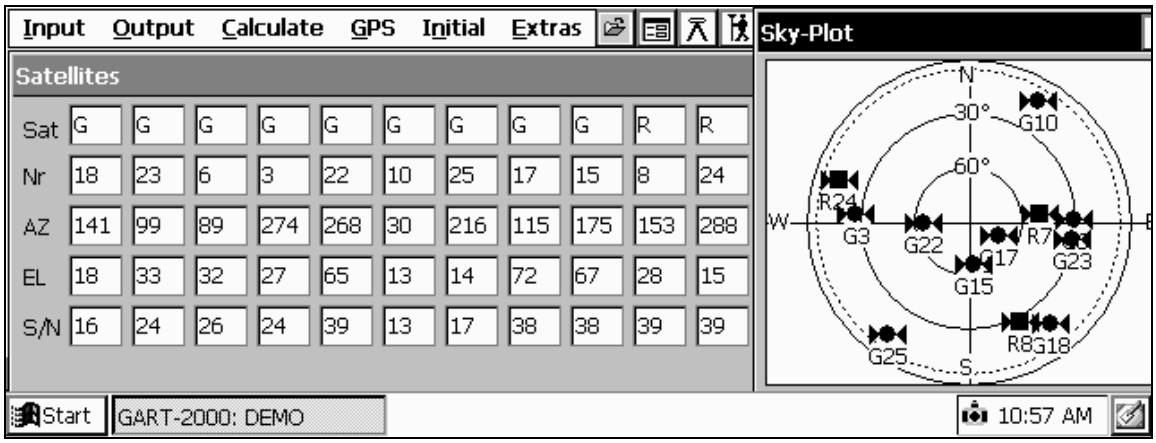


Figure 4-143: Satellite Geometry in Sky Plot

In the section **Stop&Go** you can record quasistatic measurements. To do so, check the **Active** box. In the field **Site** you can choose a point designation. When inserting a number, this is automatically increased by one for the next point. In the field **Counter** the time period is entered for which you intend to observe a point.

Use the **<Start>** -button to start the **Stop&Go** session and to store the rawdata in the receiver's memory.

Press the **<Stop>** button when arriving at your first Site. The point name is written as an event into the raw data file and the field **Counter** counts down. When the time has expired, an acoustic signal is sounded by way of confirmation. You can then seek out the next point and set the next event with the button **<Stop>**. If you want to end the data recording earlier than specified in the **Counter** field, press the button **<Go>**.

To end the **Stop&Go** session and the raw data recording uncheck the **<Active>** box.

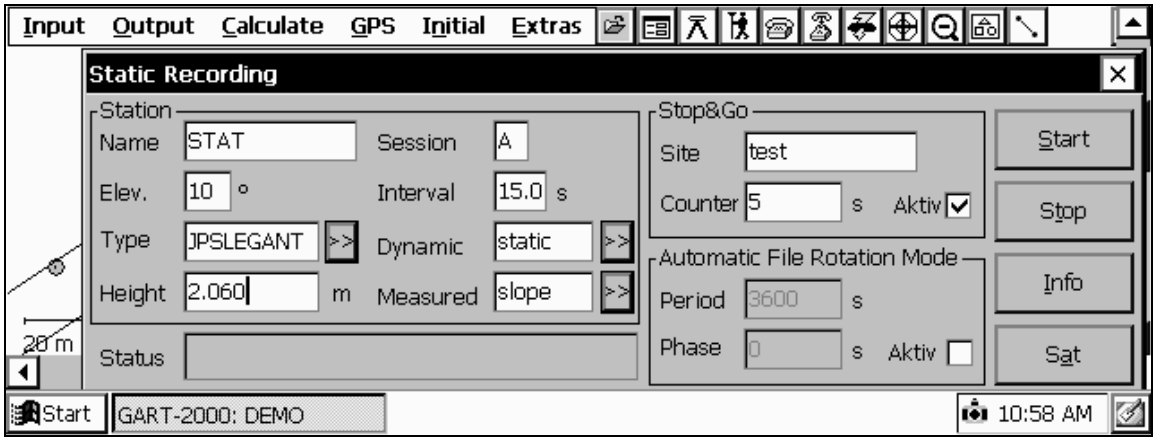


Figure 4-144: Recording in Stop&Go mode

In the section **Automatic File Rotation Mode** you can subdivide the static recording into synchronised raw data files. To this end, check the **Active** box. In the field **Period** the time range of the raw data files is entered in seconds. The starting point of the file division refers to 00:00 GPS system time. For example, if you have chosen a 4-hour file division and start your recording at 07:00, the next data file will then begin at 08:00. By means of the field **Phase** you can defer the starting point of the file division.

Thanks to this module, you are given the capability of coordinating your data with one another in advance during simultaneous multiple station recording and facilitating evaluation in the postprocessing stage.

4.4.5 Telephone

In the submenu ***GPS > Select Reference*** the data connection between the mobile station and the reference station or a reference network can be established via GSM.

To initialise the cell phone (GSM) - choose the ***GPS > Telephone*** submenu or press the quickdial button shown above. The opened window shows a list in which the telephone number of the base station cell phone (GSM)-modem or reference network can be chosen.

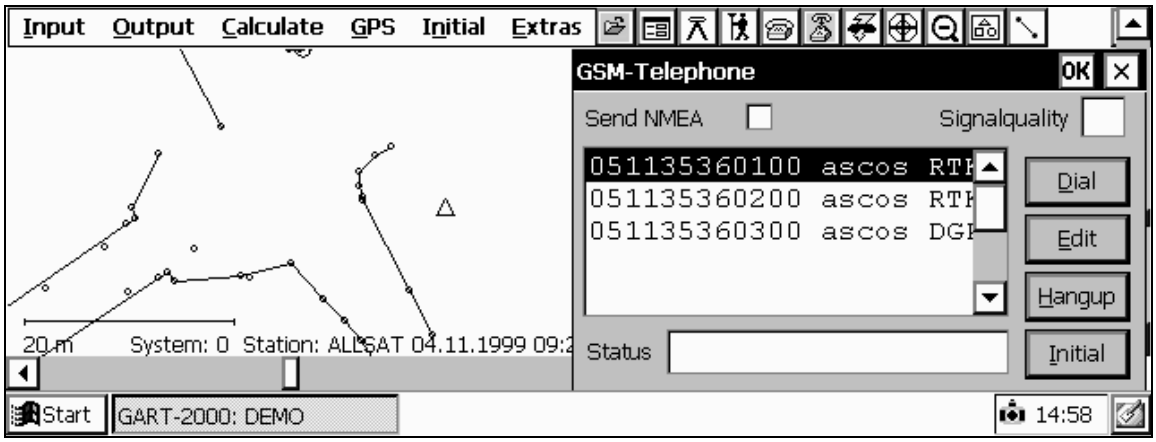


Figure 4-145: Telephone

Choose an existing number out of the list or enter a new one by pressing the button **<Edit>** in an empty row. Up to 20 numbers can be saved.

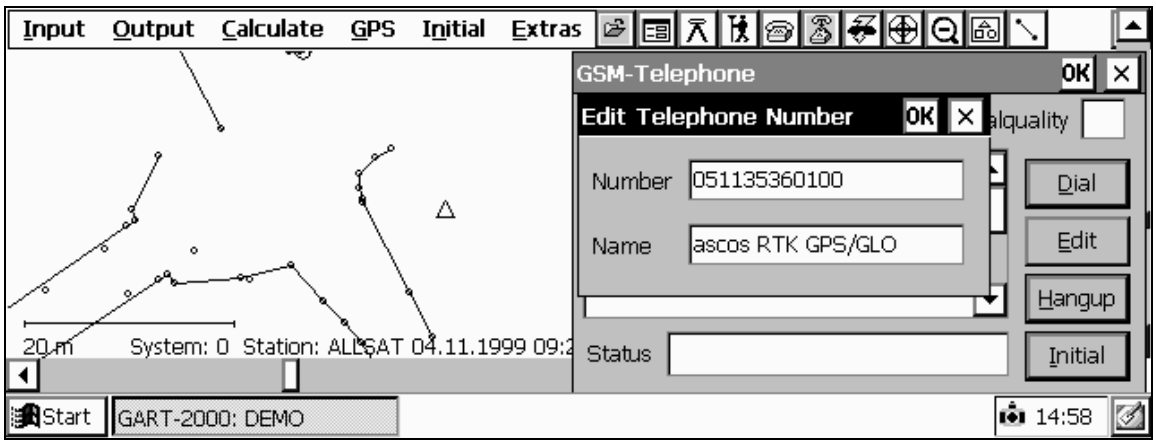


Figure 4-146: Edit Telephone Number

To choose a not saved number, click in a free cell in list and add the new telephone number in frame **<Edit>**. Up to 20 numbers can be saved.

Once the number of the Base controller is selected, press **<Dial>** to dial. If a connection with the Base controller is build up the Status field shows ***"Connected"***. Exit the telephone submenu with **<OK>** and check in the Radio field in the GPS-Measurements window if corrections are received.

To stop the telephone connection, press the quickhangup button or the button **<Hangup>** in the Menu GSM-Telephone.

The quickdial button dials the last selected telephone number and closes the window ***cell phone (GSM)-Telephone*** if a connection is build up.

The field **Signal Quality** displays the current GSM reception strength. This can reach 32 in the case of an M-20 or TC-35 from Siemens.

To work with a reference network instead of a single Base station press the checkbox **<Send NMEA>** to make the Rover receiver send it's position to the master control station.

By pressing the button **<Initial>** configure the telephone initialisation strings (PIN, etc.).

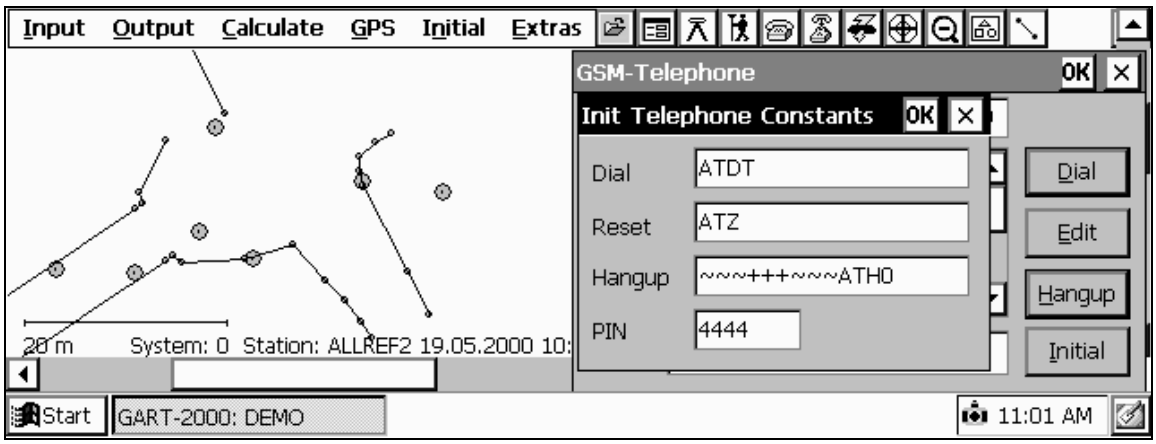


Figure 4-147: Init Telephone Constants

If you use a cell phone (GSM)-telephone without display it is very important to enter the PIN of the cell phone (GSM)-card. The commands are AT-commands. Read your telephone manual for the necessary commands concerning your cell phone (GSM)-telephone. The **<OK>** key confirms your changes and brings you back to the previous menu. The **<X>** key rejects the changes.

The **Status** row shows the state of the cell phone (GSM) telephone:

"Telephone initialised"	The cell phone (GSM) telephone is set to its default settings.
"Dialling 051135360100"	Pressing the button **<Dial>** the cell phone (GSM) telephone builds up the connection to the Base controller. The dialled number will be shown.
"PIN OK!"	The PIN is accepted.
"Connected"	The Rover receives differential correction data from the Base receiver. You may close the telephone submenu.
"No connection"	The connection to the Base controller could not be build up. Please try to dial again.
"Hangup"	After pressing the **<Hangup>** -button the connection will be cut off.
"PIN ERROR"	The entered PIN was not accepted.
"No connection to GSM-phone!"	***GART-2000® CE*** could not build up a connection to the cell phone (GSM)-phone. Please control if the cell phone (GSM)-phone is connected correctly to the Rover receiver.

The **<OK>** button closes the Telephone window.

4.4.6 NTRIP

Networked Transport of RTCM via Internet Protocol (NTRIP) is an application-level protocol that supports streaming GNSS data over the Internet. It requires an internet-connection and is based on the Hypertext Transfer Protocol (HTTP).

Differential correction data can be disseminated to stationary or mobile users over the Internet via NTRIP, allowing simultaneous PC, Laptop, PDA, or receiver connections to a broadcasting host.

You can achieve wireless Internet access through Mobile IP Networks like GSM, GPRS, EDGE, or UMTS.

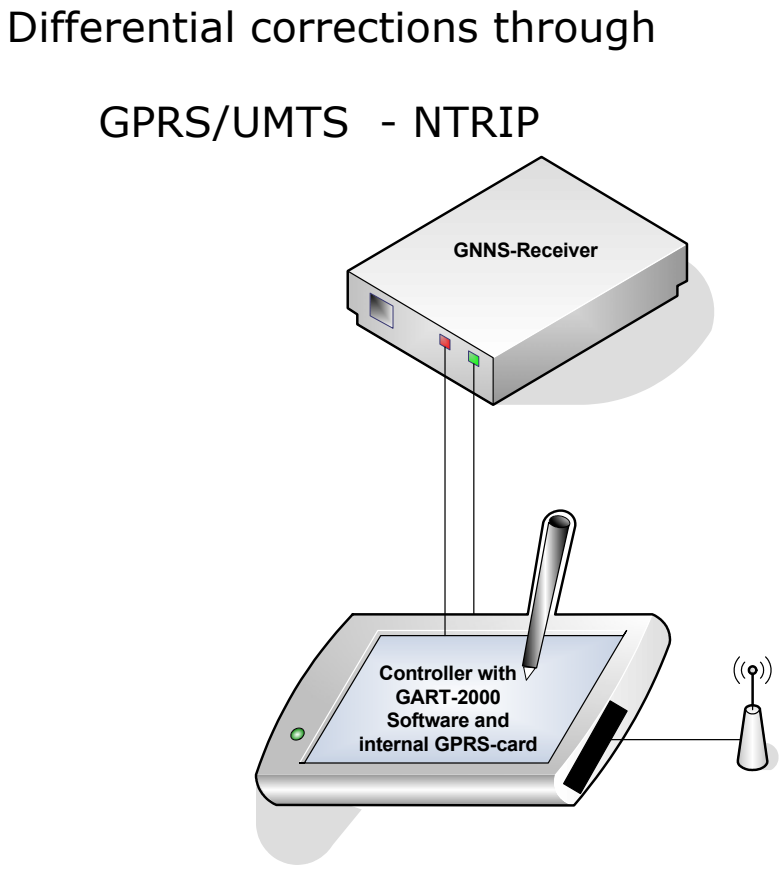


Figure 4-148: Drawing of NTRIP

4.4.6.1 Find out your GSM/GPRS-Modem

Ensure that your GSM/GPRS Modem card is recognized correctly by the operating system.

If you couldn't find your GSM/GPRS Modem in the list, try to install a new driver for your GSM/GPRS Modem card or contact the manufacturer.

Select the menu ***Start > Settings > Network > Dial-up Connections.***

Typically there is an application that sets the PIN for your SIM-Card on your GSM/GPRS Modem. If it is not available and if you have problems with setting the PIN manually, contact

Allsat GmbH network+services
Am Hohen Ufer 3A, 30159 HANNOVER, Germany
ALLSAT-Telephone Service: +49 (0)511 - 30 399 0
ALLSAT-Email Service: software@allsat.de

4.4.6.2 ALLSAT NTRIP-Client to receive correction data from Internet

If you are using ***GART-2000® CE*** with an enabled NTRIP module, you can start the *ALLSAT NTRIP-Client* under the menu ***GPS > NTRIP.***

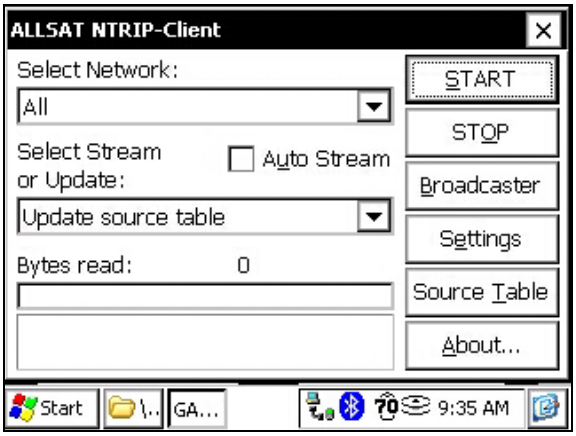


Figure 4-149: ALLSAT NTRIP - Client dialog

Click on the **<Broadcaster>** button to set the IP address and remote port of the NTRIP-Server. It is only allowed to use numbers of a given form (HostIP:Port). In the field **<User-ID:Password>** enter the assigned user-id and password to you. If the NTRIP-Server requires your position check **<Send NMEA>** checkbox to forward the NMEA message from the GPS receiver to server.

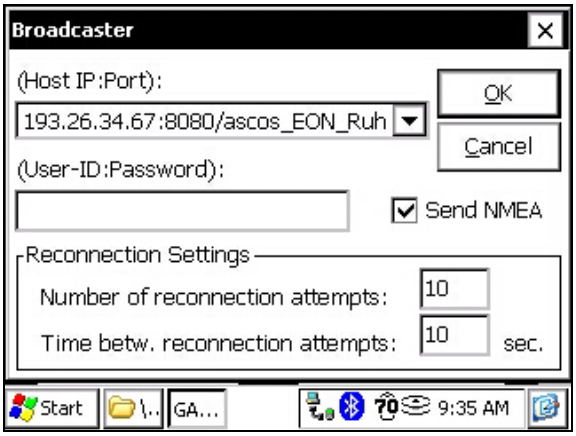


Figure 4-150: NTRIP - Broadcaster

Furthermore the **<number of reconnection attempts>** and the **<time between reconnection attempts>** can be set.

Click on the **<Settings>** button and configure under *COM Port Settings* button which COM Port, baudrate, databits, parity, stop bits should be used for the output of the correction data coming from the NTRIP-Server.

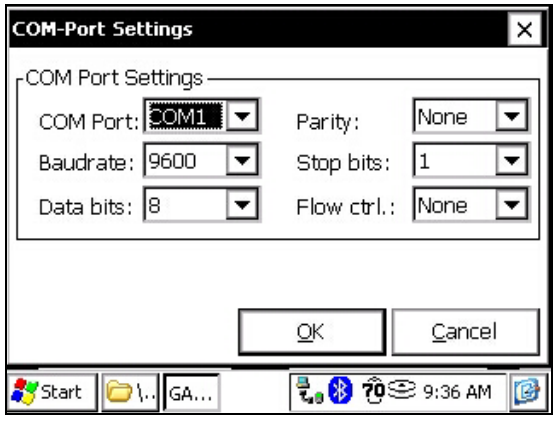


Figure 4-151: NTRIP - COM-Port Settings

Now click on the **<START>** button to receive the source table with the available correction data streams. The download of the source table can take a while. If the downloading was successful, you will receive an acknowledgement message.

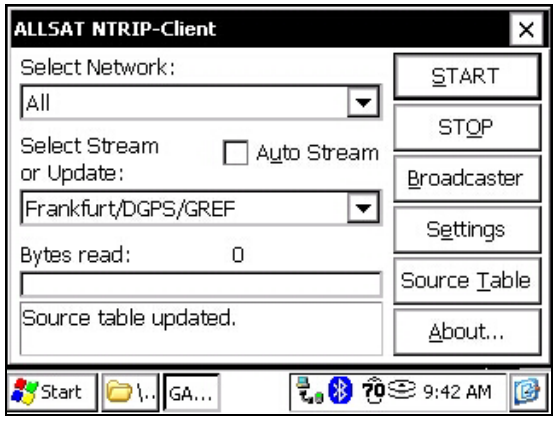


Figure 4-152: NTRIP – Receiving a source table with available correction data streams

For more detailed information about the particular data streams click on the **<Source Table>** button.

Scroll down to *Requests NMEA* entry and check if the NTRIP-Server requires your position for this correction data stream.

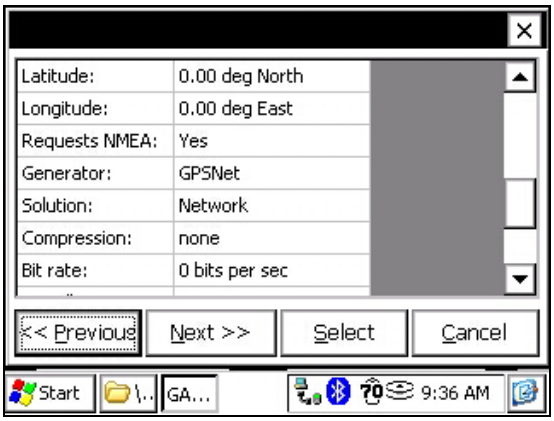


Figure 4-153: NTRIP – Source Table

Choose a correction data stream and click on **<START>** button.

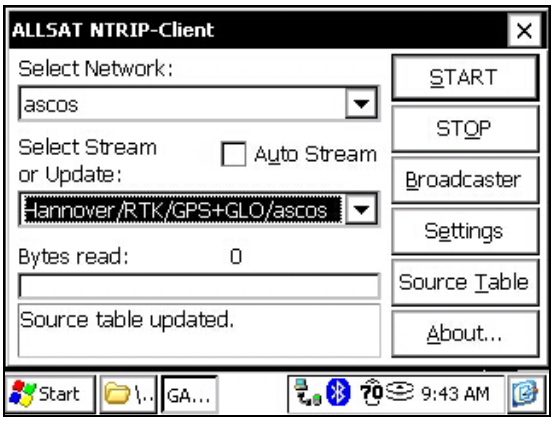


Figure 4-154: NTRIP – Choosing a correction data stream

Only if the NTRIP-Server requires your position, it will wait until you send a NMEA message to the server. Afterwards it will start sending correction data. The NTRIP-Client transmits the data to the selected COM port and shows bytes read.

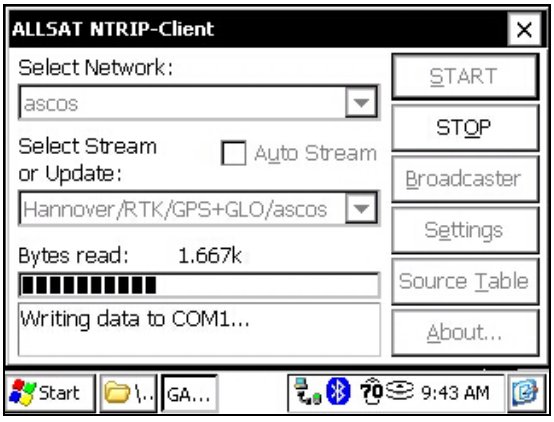


Figure 4-155: NTRIP – Sending correction data

You can close the window now. The NTRIP-Client application is running in background. You can observe under ***In > Measurements*** if you are receiving correction data.

To stop receiving correction data open the NTRIP-Client application using the menu again and click on the **<Stop>** button.

4.4.7 Save

Using the ***GPS > Save*** menu the current coordinates can be stored. The menu has the same functionality as ***Input > Measurements > Save***.

It is possible to average several measurements. The number of measurements to be averaged is defined in the ***Initial > Constants > GPS*** menu. The displayed standard deviations in the averaging window result from the averaging process of the measurements. To receive realistic values for the standard deviations the values will not decrease below the actual standard deviations from the GPS receiver.

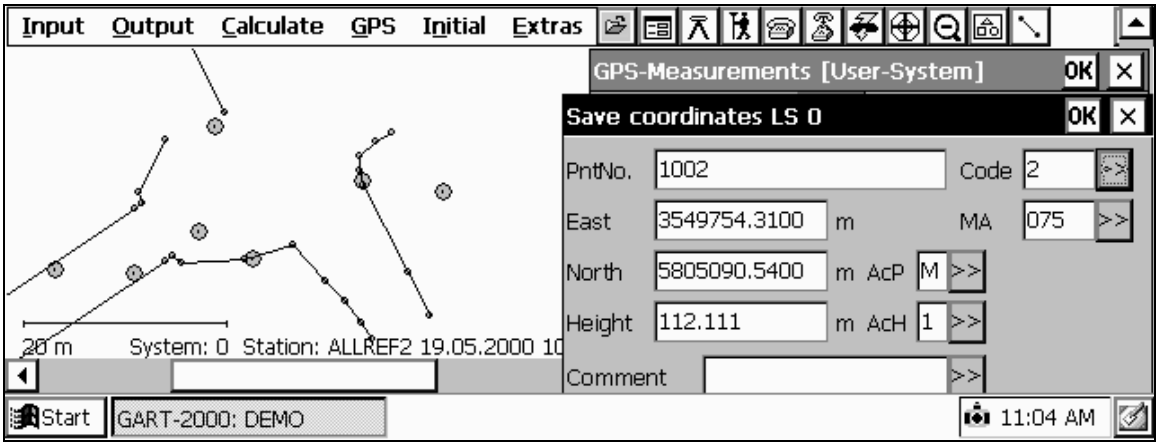


Figure 4-156: Save Coordinates

The point number can be entered after the averaging process. ***GART-2000® CE*** suggests a new point number according to the interval entered in the submenu ***Initial > Constants > Point Numbers***. Moreover the point type, the marker type and an optional comment are stored with the coordinate. In addition to that, for cadastral applications the precision of position (***LG***) and the reliability of position (***LZ***) as well as the precision of height (***HG***) and the reliability of height (***HZ***) can be changed.

The fields have the following significance:

PntNo.	Point number with up to 32 alphanumeric characters
Code	Point code (selection list is located in the file *vp_art.txt*)
String	Marker type (selection list is located in the file *vp_vmrk.txt*)
East	Easting in the user coordinate system [m]
North	Northing in the user coordinate system [m]
Height	Height in the user coordinate system [m]
AcP	Accuracy of the position: 0 - No position D - Digitized point M - Measured point R - Calculated point

	S - Control point
AcH	Accuracy of the height: 0 - No height 1 - Level 1 (lowest level, e.g. tachymeter/total station) 2 - Level 2 (intermediate level) 3 - Level 3 (highest level, e.g. height control point)
Comment	Commentary to enhance documentation of the project

A comment can be added in the **<Comment>** field to document additional point information. Every commentary entered is saved in a list and can be selected from this list once again when the next point is entered.

4.4.8 Auto Save

In addition to the storage of separate points ***GART-2000® CE*** offers the possibility to save points in constant intervals. In the ***GPS > Auto Save*** menu the coordinate-offsets can be entered and a line between the points can be automatically drawn. If the distance of the actual coordinate to the last saved point exceeds the entered difference a new coordinate will be saved automatically.

After the Measurements window has been called up, the differences are entered under the menu item ***GPS > Auto Save***. Here, the option also exists to autoconnect the saved points with lines. In the input field **T** you can also specify an interval (in seconds) after which a further measurement registration is to occur. The measurement is performed depending on what occurs first.

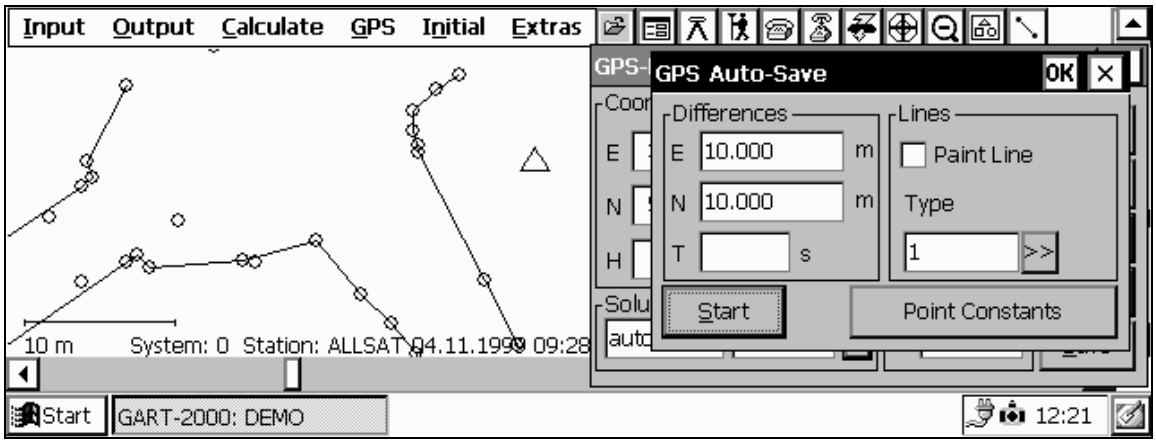


Figure 4-157: Auto Save

4.4.9 Station Shift

This function is called up via the menu item ***GPS > Station Shift***.

If the environment of the point with known coordinates marked as reference station (Base) is unsuitable for the installation of a GPS antenna, the antenna must be erected on a point with unknown coordinates. In order to perform a precise positioning nevertheless, a reference station adjustment is required. To this end, after initialisation of the reference station a point with known coordinates must be observed with the Rover.

If you work with a Base that is transmitting Base coordinates which are off for more than 5 – 10 m from the true Base position you will get systematical errors in your RTK solution even if

you do a standard transformation to fit yourself into the local system (***Calculate > Polar/GPS transformation***).

Therefore Topcon and Ashtech rovers support a feature to ignore the Base coordinate transmitted in the differential corrections and to replace it with a user defined Base coordinate.

The Station Shift function supplies the neccessary tools to compute and apply a corrected (shifted) Base coordinate on the Rover side.

The following steps must be performed:

Initialisation of the Base via ***GPS > Start Base*** with the aid of an approximate solution **(<Nav.Sol.>**, **<OK>**).

Initialisation of the Rover via ***GPS > Start Rover***. Here, wait for the resolution of the ambiguities (display: "***fixed***").

Proceed with the Rover first of all to a point with known coordinates.

Perform the adjustment via ***GPS > Station Shift*** as described below.

Observe all other points in the customary manner.

By selecting the menu item, the dialog opens up to calculate the reference station adjustment.

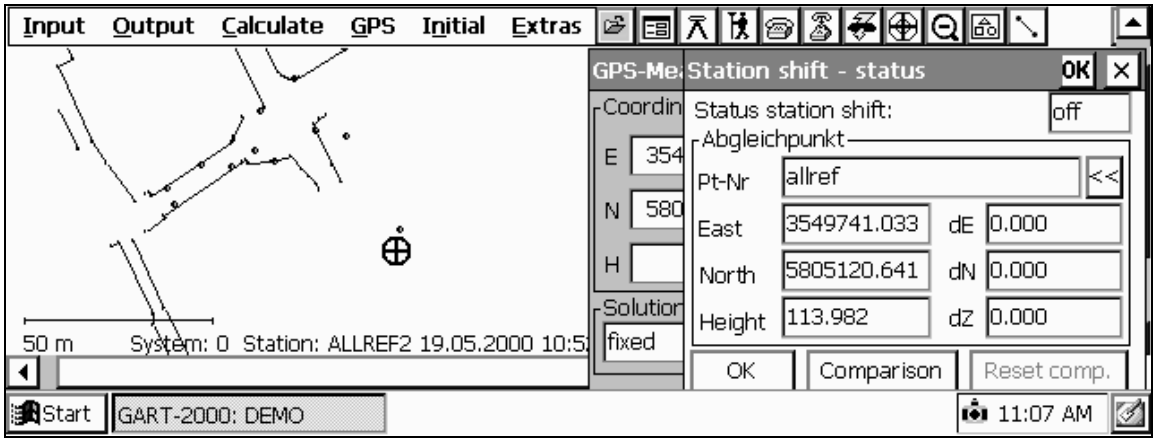


Figure 4-158: Input of debit plane coordinates for Station Shift

The comparison point is to be specified in this first dialog. This is the point with known coordinates currently observed with the Rover. Make sure that the GPS-Measurements dialog is opened simultaniously. Enter this point in the field Pt-No via the graphic, via the << button or via the keyboard. The nominal coordinates are displayed in the fields East, North and Height. In the fields dE, dN and dZ the computed alterations in the reference station coordinates for East, North and Height are displayed after the comparison has been successfully completed.

When the point has been selected, the calculation can be started with the button <Comparison>. A further dialog opens up:

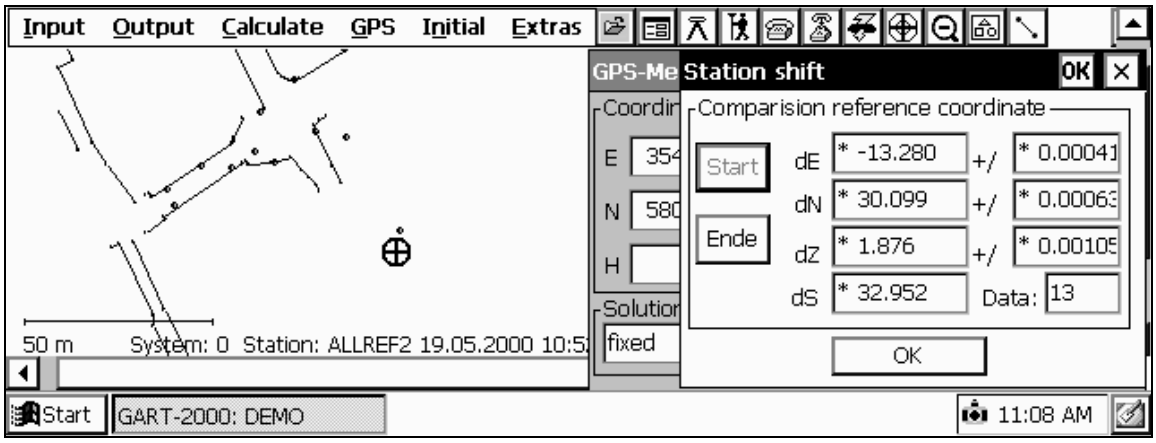


Figure 4-159: Station Shift calculation

The calculation is started via the button **<Start>**. In the fields **dE**, **dN** und **dZ** the current results of the comparison are displayed for East, North and Height as well as their standard deviations in the fields **+/-**. These shift values correspond to the offset between navigation solution and true position of the Base.The field **Data** displays the observed quantity of data. If the attained accuracy is sufficient, you can end the comparative calculation with the buttons **<End>** or **<OK>**.

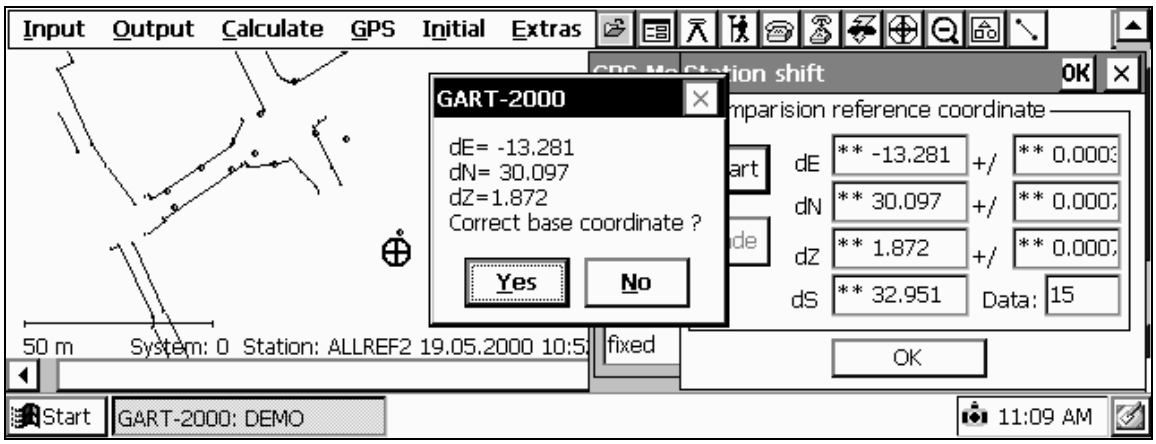


Figure 4-160: Security query for Station Shift

The result of the comparison is displayed once again in a further window. To accept the result, confirm with **<Yes>**.

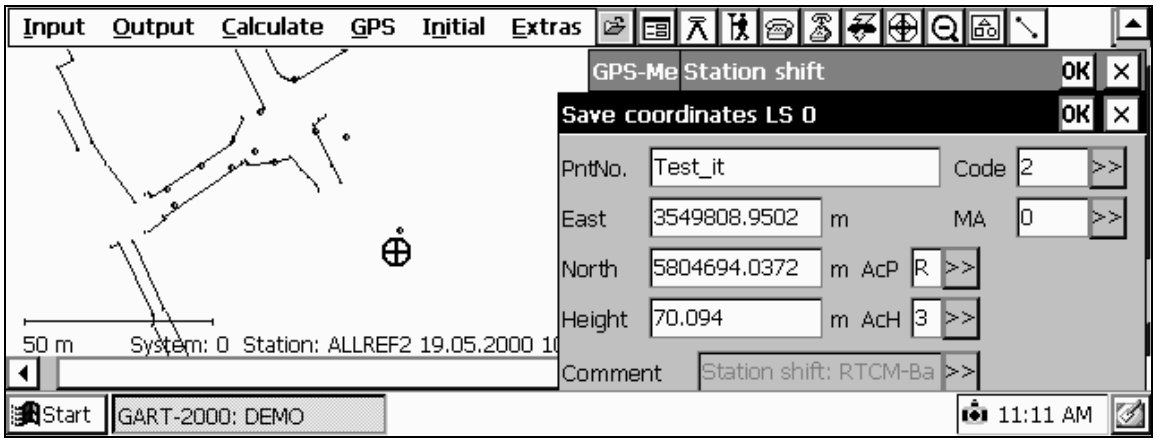


Figure 4-161: Saving of aligned plane coordinates of reference station

The new (aligned) coordinates of the reference station can subsequently be saved. To do so, enter a point number in the dialog that opens up. In the field **Comment** a corresponding remark is entered automatically. Save the coordinates with **<OK>**.

You are now returned to the initial dialog. The word ***"on"*** appears in the field **Status Station Shift**. In the fields **dR**, **dH** and **dZ** the computed modifications for East, North and Height are now displayed.

Quit the dialog with **<OK>** in order to apply the reference station shift. Now all measurements made with these settings will be shifted according to the displayed values.

In the menu ***GPS*** the activity of the reference station alignment is shown by a tick against the corresponding submenu.

To quit the dialog without applying the reference station shift hit the **<X>** button.

If you wish to invalidate the reference station alignment, in order to re-perform the calculation via a different point, press the button **<Reset Shift>**. The coordinates of the points observed up to that point are retained. Please note, however, that any subsequently observed points are calculated using the approximate coordinates of the Base, which are considerably more imprecise. When setting up a new Base the reference station shift is resetted automatically.

ATTENTION: Even if you leave the program ***GART-2000® CE*** in the meantime, the reference station shift remains active for the individual project.

4.4.10 Log Unianalyse

Using the function **< Log Unianalyse >** the actual settings and measured values can be saved. In the actual project folder the data are stored in the file “projectname.grt”. In this window you have the possibility to activate the function.

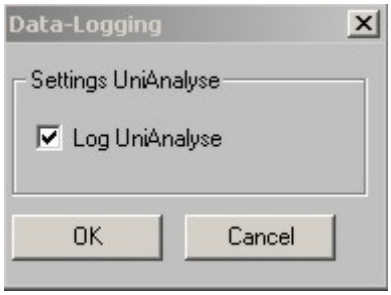


Figure 4-162: Data-UniAnalyse

4.4.11 Script to Receiver

Having chosen the correction data format ***Standard NMEA***, the following window appears after activating ***GPS > Script to Receiver***:

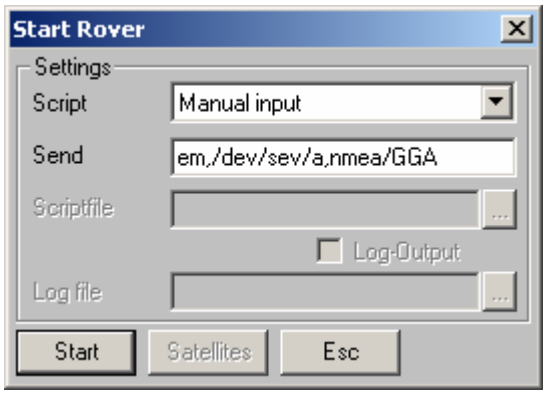


Figure 4-163: Start Rover

In the field **<Script>** the user has three possibilities to initialise the receiver:

- ***No Script:*** Use this kind of initialisation if the receiver outputs data automatically and it it does not have to be initialized with additional commands.
- ***Manual Input:*** In the field **<Send>** single commands for the initialisation of the receiver can be entered.
- ***File:*** The initialisation occurs using a Script file which can contain several commands. Pressing the button **<...>** beside the field **<Script file>** a file can be selected.

Using the button **<Satellite>** a skyplot is displayed. After ***GART-2000® CE*** has built up the connection to the receiver, the received satellites are indicated.

By clicking the **<OK>** button data are transferred to the GPS receiver and the receiver is set into the mobile mode.

At the moment the following NMEA messages are supported by ***GART-2000® CE***: GGA, GSV and GST.

Initialisation:

Before you can use ***GART-2000® CE***, some pre-settings have to be entered in the main menu ***Initial***. Some inputs are stored cross-project, others refer only to the actual project.

4.5 Initial

Before surveying with ***GART-2000® CE*** there are some settings to be done in the ***Initial*** menu. Some of the settings are saved globally for all projects; some are only used for the actual project.

4.5.1 Project

In the software ***GART-2000® CE*** all coordinates and measurements are assigned to a project. To work with ***GART-2000® CE*** first of all a new project must be initialised or an existing project must be opened. Use the ***Initial > Project*** submenu or the button shown above. In the following dialog enter a name for a new project (up to 12 characters) into the field **Project** or mark an existing project in the **Projects** list. To open the project, press the button **<OK>**.

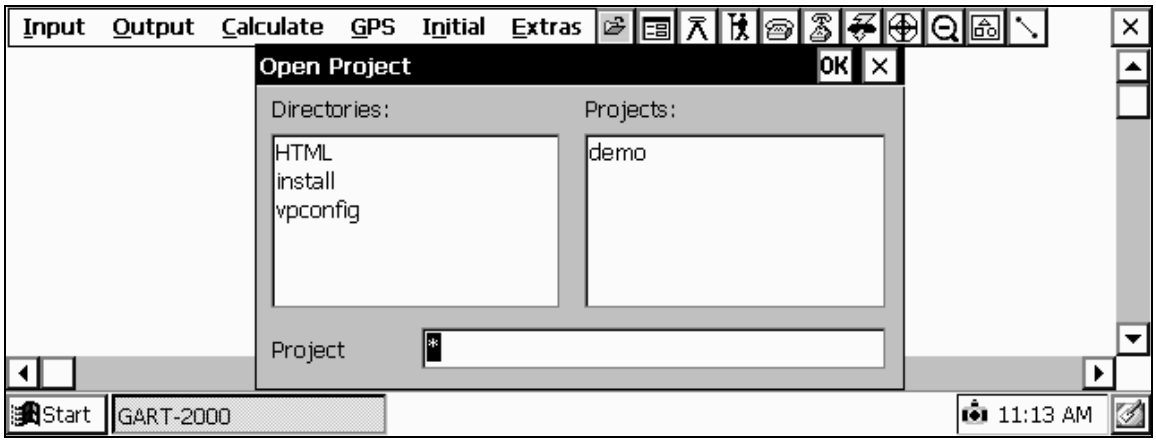


Figure 4-164: Open Project

If you enter a new name for a project ***GART-2000® CE*** creates a new subdirectory with the same name like the project together with a new database.

4.5.2 Delete Project

To delete a project first open the project with the ***Initial > Project*** submenu. Afterwards use the ***Initial > Delete Project*** submenu. An inquiry with the name of the actual project is shown. Answer **<Yes>** to delete the project.

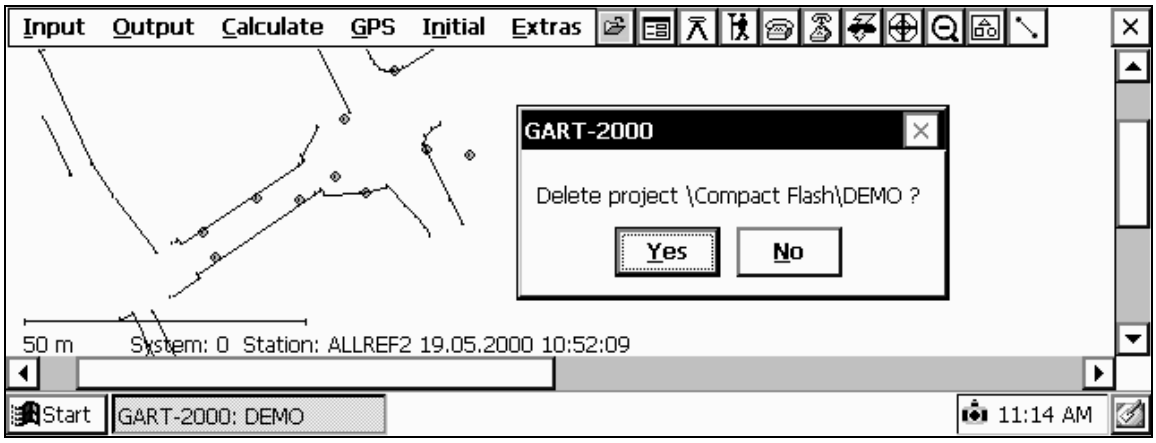


Figure 4-165: Delete Project

To avoid unintended deletion of data a second inquiry is shown.

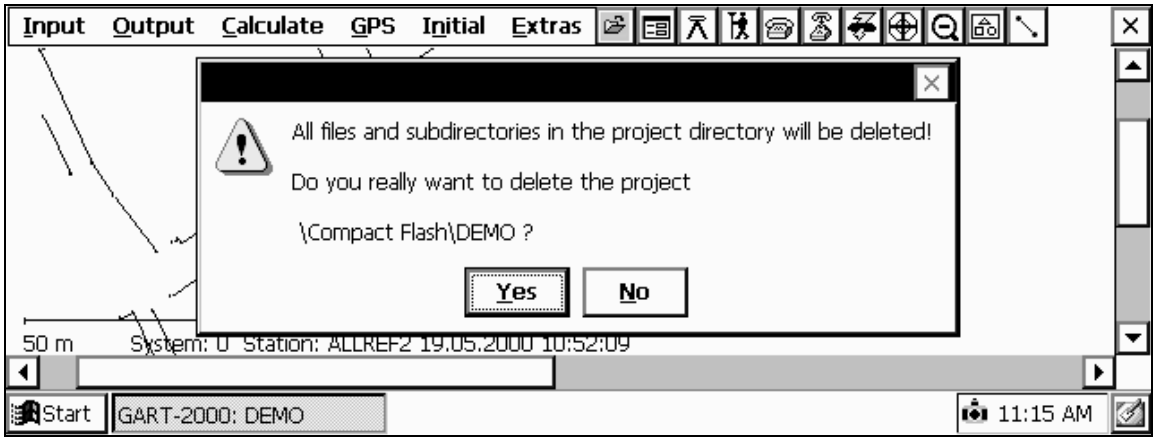


Figure 4-166: Do you really want to delete the project?

If the button **<Yes>** is pressed, the project's data will be deleted and cannot be restored. The window ***Open Project*** is shown to choose another project to be opened.

4.5.3 Constants

In the ***Initial > Constants*** menu the most important settings for surveying with ***GART-2000® CE*** can be done.

4.5.3.1 General Constants

The ***Initial > Constants > General*** menu offers some general settings.

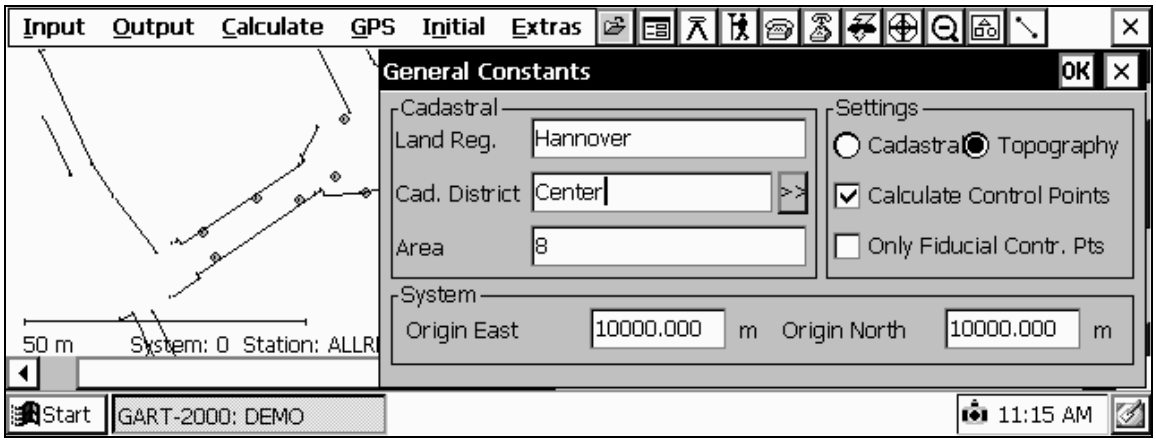


Figure 4-167: General Constants

The meanings of the different fields are as follows:

Land Reg.	Information about the land registry.
Cad. Zone	Information about the cadastral zone. Only used for area calculations.
Area	Information about the area. Only used for area calculations.
Cadastral	Only plane coordinates are used.
Topography	Coordinates with plane and height.
Calculate Control Points	Calculate Control Points. If the checkbox **Calculate Control Points** is activated for every measurement on a control point a coordinate will be calculated.
Only Fiducial Ctrl Pnts	Only nominal points can be control points. Coordinates calculated from measurements cannot be used as a control point. This checkbox is deactivated by default.
Origin East/North	Definition of the origin of a local coordinate system. Only used for indirect control surveys in Germany.

4.5.3.2 GPS-Constants

The ***GART-2000® CE*** software initialises GPS receivers using the constants in the ***Initial > Constants > GPS*** submenu.

Alternatively, use the button shown above to choose this menu.

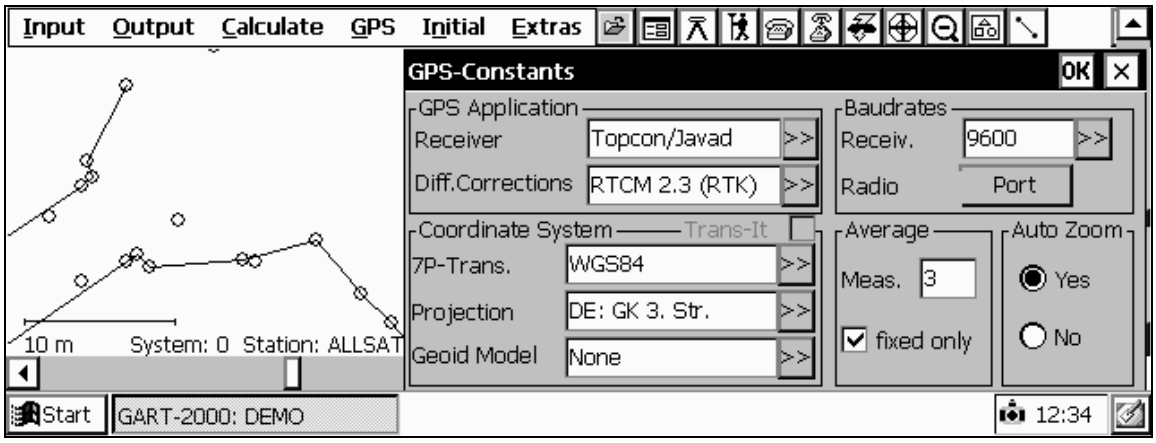


Figure 4-168: GPS-Constants

There exist the following settings:

4.5.3.2.1 GPS Application

The used differential correction formats can be chosen from a list these two fields. ***GART-2000® CE*** supports the following differential correction formats for GPS receivers:

Ashtech CPD (RTK)	Ashtech internal corrections for cm-accuracy
Ashtech RTCM (DGPS)	General corrections for m-accuracy
Ashtech RTCM 2.1 (RTK)	General corrections for cm-accuracy
Trimble CMR (RTK)	General corrections for Trimble 4000 series
Topcon RTCM (DGPS)	General corrections for m-accuracy
Topcon RTCM 2.1 (RTK)	General corrections for cm-accuracy
Topcon RTCM 2.2 (RTK)	General corrections for cm-accuracy
Topcon RTCM 2.3 (RTK)	General corrections for cm-accuracy
Topcon RTCM 3.0 (RTK)	General corrections for cm-accuracy
Topcon CMR (RTK)	General corrections for cm-accuracy
Topcon CMR+ (RTK)	General corrections for cm-accuracy
Topcon JPS (RTK)	Topcon internal corrections for cm-accuracy
Topcon OmniSTAR	For Topcon-receiver, which accept OmniSTAR correction data; m-accuracy
Sokkia RTCA	Sokkia internal corrections for cm-accuracy
Sokkia RTCM (DGPS)	General corrections for m-accuracy
Sokkia RTCM 2.2 (VRS)	General corrections for cm-accuracy
Sokkia CMR (RTK)	General corrections for cm-accuracy
Thales RTCM (DGPS)	General corrections for m-accuracy
Thales RTCM 2.2 (RTK)	General corrections for cm-accuracy
Thales LRK (Long Range) RTK	Thales internal corrections for cm-accuracy

Leica RTCM (DGPS)	General corrections for m-accuracy
Leica RTCM 2.1 (RTK)	General corrections for cm-accuracy
Leica RTCM 2.2 (RTK)	General corrections for cm-accuracy
Leica CMR (RTK)	General corrections for cm-accuracy
Leica CMR+ (RTK)	General corrections for cm-accuracy
Leica RTK	Leica internal corrections for cm-accuracy
NavCom Auto-Input	Can be chosen for a rover; the best correction is chosen based on a priority list (RTK, RTG, WCT,RTCM, WAAS)
NavCom NCT (RTK)	General corrections for cm-accuracy
NavCom RTCM (DGPS)	General corrections for m-accuracy
NavCom RTCM 2.2 (RTK)	General corrections for cm-accuracy
NavCom CMR (RTK)	General corrections for cm-accuracy
NavCom StarFire (RTG)	General corrections for m-accuracy
NavCom StarFire (WCT)	General corrections for m-accuracy
NavCom SBAS (WAAS/EGNODS)	General corrections for m-accuracy
Septentrio RTCM (DGPS)	General corrections for m-accuracy
Septentrio RTCM (RTK)	General corrections for cm-accuracy
Standard NMEA	General format for use of other receiver types (e.g. for GIS-applications)

4.5.3.2.2 Trans-It

With the Trans-It database ***GART-2000® CE*** is able to calculate national coordinates with a high degree of accuracy without the time-consuming search for control points. The position of the user is used every second in order to calculate dynamically the most precise 7P datum transformation set.When the checkbox is selected, the following window opens up:

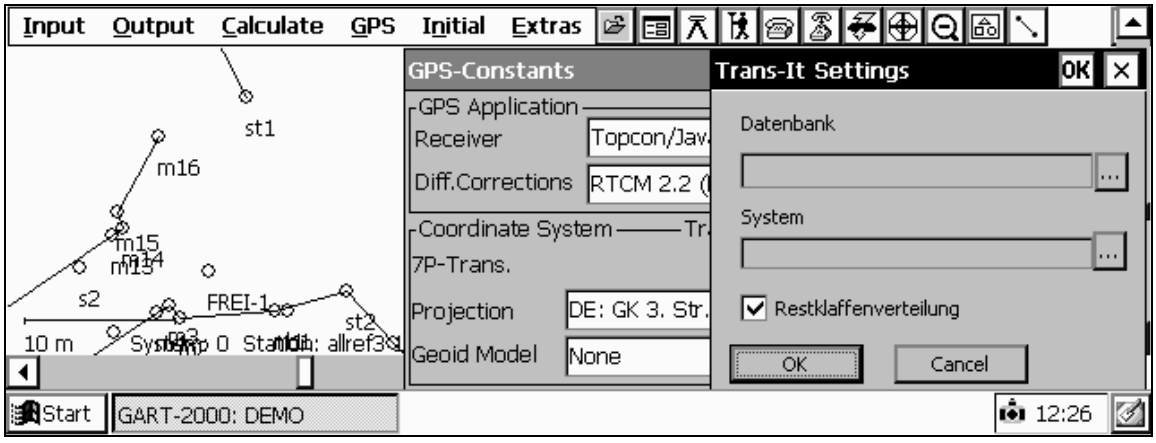


Figure 4-169: Trans-It Settings

Under Database a file with the suffix *._DB must be selected.

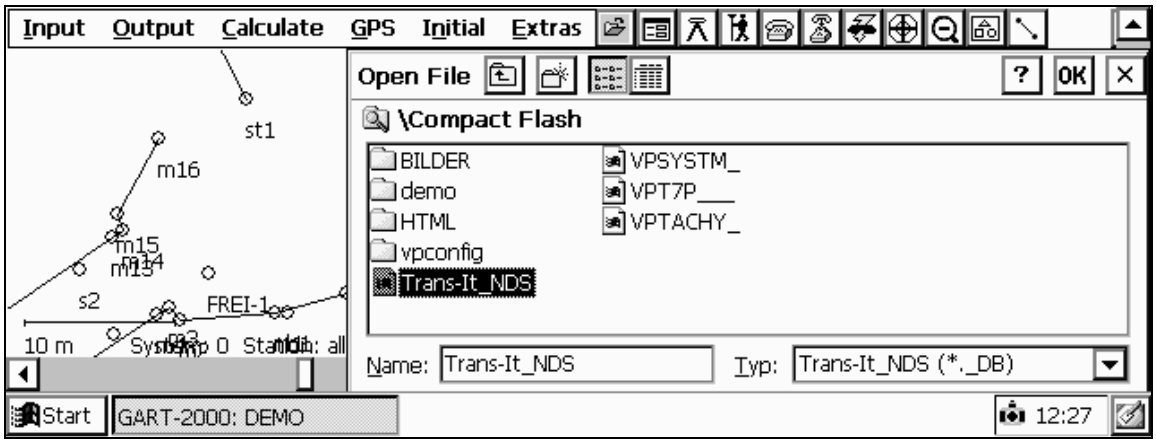


Figure 4-170: Choose Trans-It database

An appropriate system must now be selected and confirmed with **OK**.

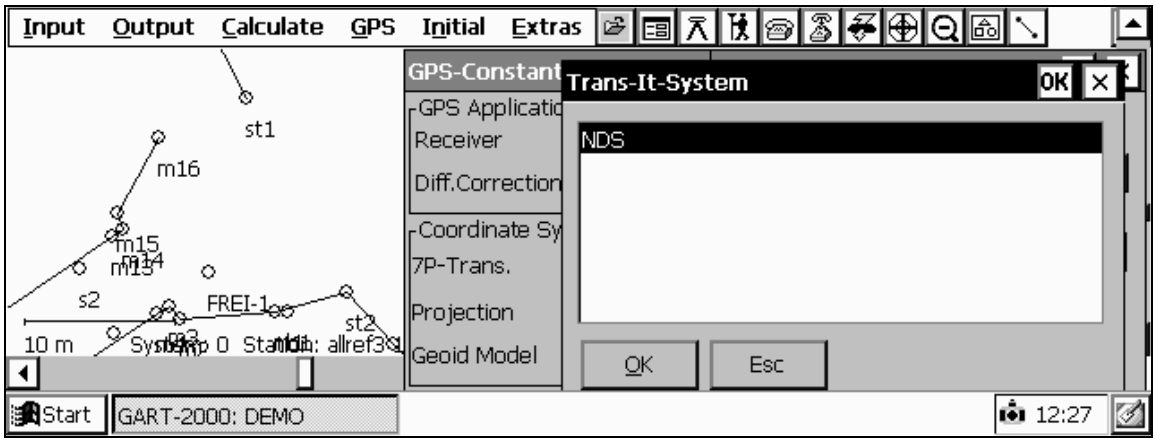


Figure 4-171: Choose Trans-It.-System

The system is confirmed with **OK** and you are returned to the Trans-It Settings dialogue. The residual error distribution/weighting (1/s) is activated with the checkbox **Residual Estimation**.

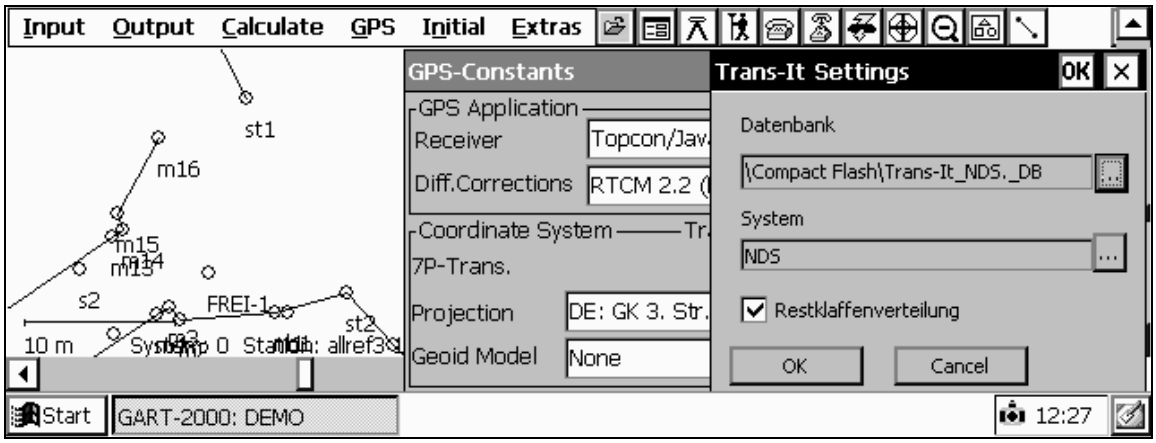


Figure 4-172: Trans-It Settings

Your entries are confirmed with **OK** and you are returned to the **GPS Constants** dialogue, where the **Datum** field is deactivated.

4.5.3.2.3 Datum

GART-2000® CE transforms the WGS84 coordinates in real time into a user system using a 7P-transformation. The transformation parameters can be selected from a list, which contains user definable entries (e.g. User003) with pushing the button **<OK>**:

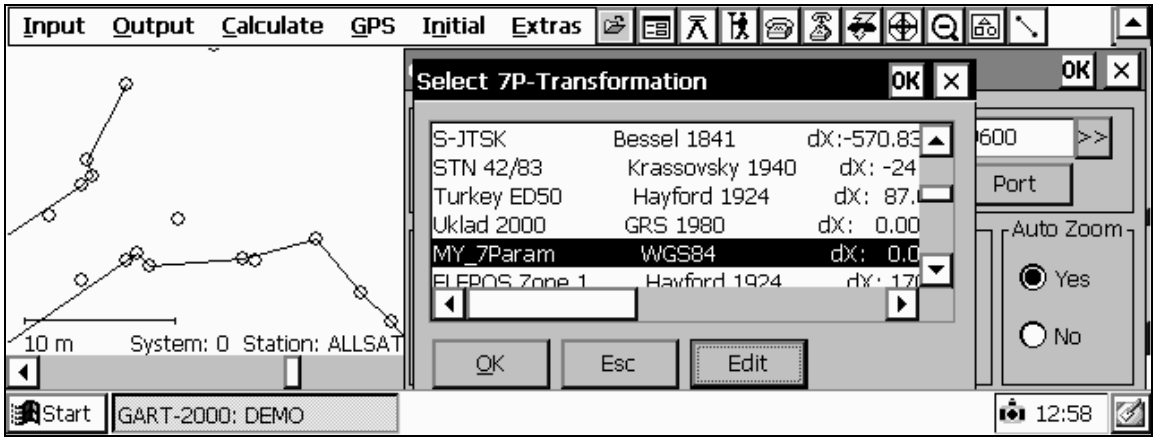


Figure 4-173: Select 7-Parameter-Transformation

Use the button **<Edit>** to change the seven parameters.

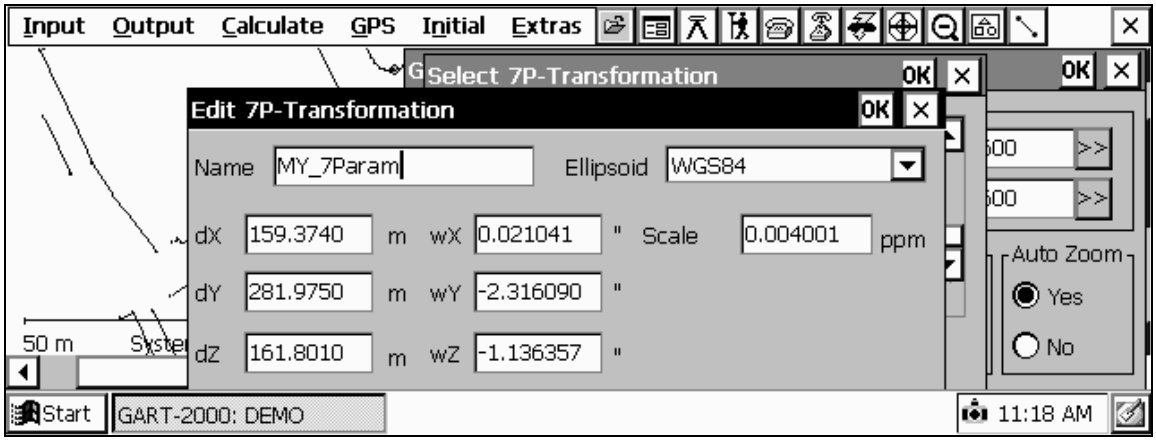


Figure 4-174: Edit 7P-Transformation

The entries have the following meanings:

Name	Name of the set of transformation parameters (user-definable).
Ellipsoid	Ellipsoid of the user system.
dX, dY, dZ	Translations for X-, Y- and Z-axis.
wX, wY, wZ	Rotation with respect to X-, Y- and Z-axis.
Scale	Scale factor in ppm

The ellipsoid can be selected from the corresponding list, whereby the selection available varies according to the ***GART-2000® CE*** version in use.

4.5.3.2.4 Projection

In the projection dialog the projection for the user system can be selected. The following projections are currently supported:

- Gauss-Krüger second to fifth sector
- UTM
- Lambert (Belgium, France, Estonia)
- Soldner (Berlin)
- NGO48 (Norway)
- KKJ (Finnland)
- UK National Reference System
- Irish Grid
- CH1903, CH1903+ (Switzerland)
- Nederland RD

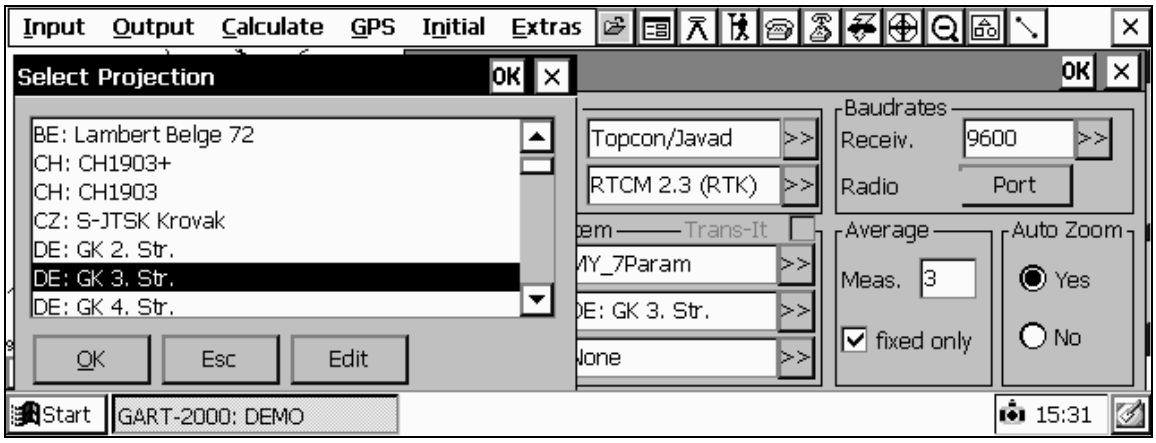


Figure 4-175: Select Projection

Further projections are in preparation or will be developed on demand. ***GART-2000® CE*** transforms the WGS84 coordinates in real time into a user system using the 7P-transformation and the projection (e.g. UTM Zone 32). The settings for the projection are saved for every project; the settings for the 7-Parameter-Transformation are saved global for all projects.

A user-defined projection can be specified via the **<Edit>** button. To do so, the last available entry in the projection list should be highlighted.

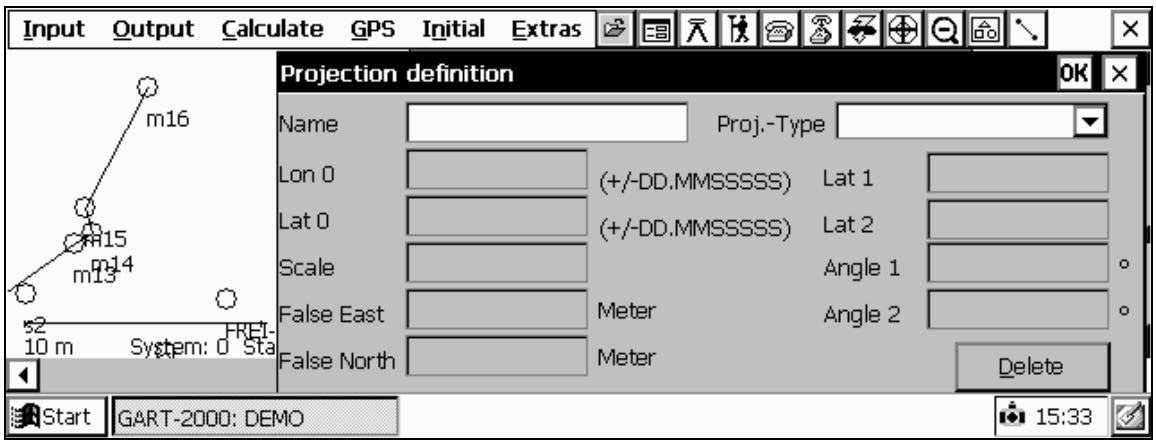


Figure 4-176: Projection Definition

The new projection is saved by pressing **OK**.

4.5.3.2.4.1 Baudrates: Radio

GART-2000® CE initializes the radio port of the GPS receiver with the baudrate set in here to communicate with the radio or cell phone (GSM)-modem.

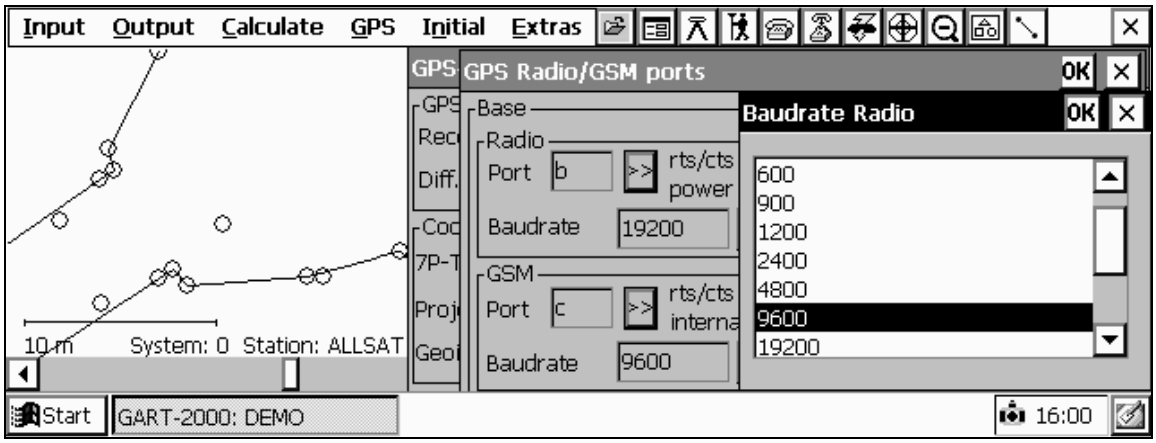


Figure 4-177: Baudrate Radio

The **<Port>** button is displayed for Topcon receivers.

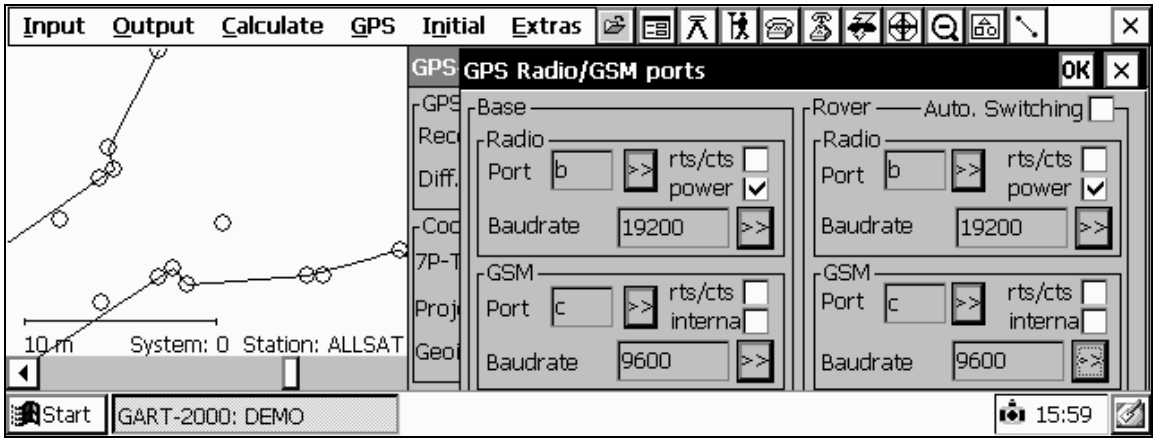


Figure 4-178: GPS Radio port

This dialogue enables you to select how the rover receives correction data.

The choice of the baudrate determines the data transfer speed with the radio or GSM modem. The GPS receiver is set to this baudrate during the initialization of the mobile receiver.

When the **<power>** checkbox is activated, the radio modem is supplied with electricity from the receiver.

The **<internal>** checkbox must be selected when the GSM modem is integrated in the GPS receiver (e.g. in the Hiper from Topcon).

When radio and GSM communication is used, the function **<Auto. Switching>** can be activated at the rover. As soon as a GSM connection has been successfully established, the use of the radio port is switched to the GSM port and, when the connection has been terminated, the radio port is re-activated.

The **<OK>** button saves your entries and returns you to the previous window.

4.5.3.2.4.2 Baudrates: Receiver

GART-2000® CE initializes the controller port of the GPS receiver with the baudrate set in here to communicate with the Handheld PC.

During initialisation of the mobile receiver, the receiver is set to this baudrate.

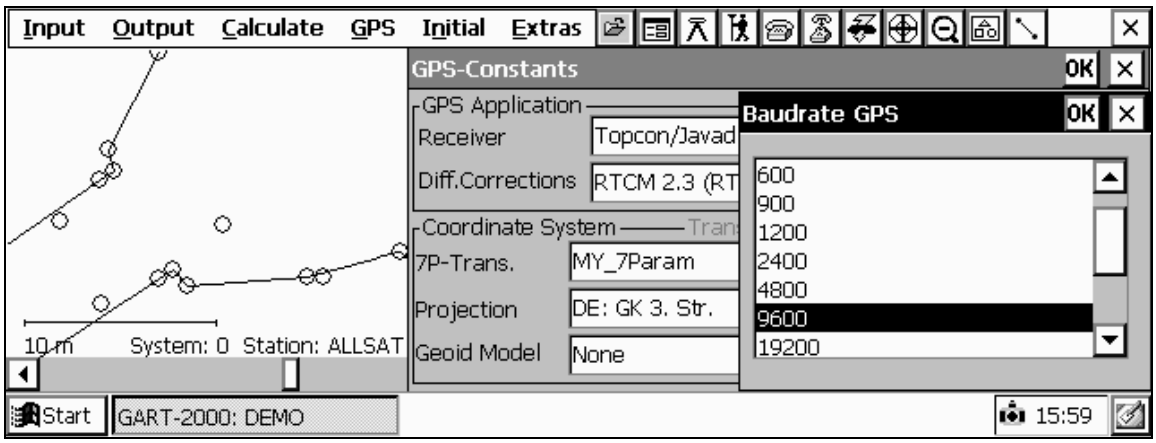


Figure 4-179: Baudrate GPS Receiver

4.5.3.2.5 Average

In this field the number of measurements to be averaged when saving a coordinate can be entered. If the checkbox **<fixed only>** is activated, only measurements with fixed ambiguities will be averaged.

4.5.3.2.6 Auto Zoom

The **Auto Zoom** function can be activated with the ***"Yes"*** radio button. In this case the zoom area of ***GART-2000® CE*** is adjusted to the actual position. If the Auto Zoom function is deactivated (***"No"***) the zoom area is kept constant. As a result, the section of the graphical representation you have selected remains visible on the display during the setting-out procedure.

4.5.3.3 Point Number Constants

The menu ***Initial > Constants > Point Numbers*** displays the pointnumber, code and marker type of the last entered point. These values are used for any future incrimination and can be edited if necessary. For cadastral applications a strict incrimination of point numbers and a check of the district number can be activated A figure can also be entered for the automatical incrementing of the point numbers. Moreover, if the appropriate checkbox is activated, a numbering district check can be performed. (Only relevant in the case of specific German federal state versions.)

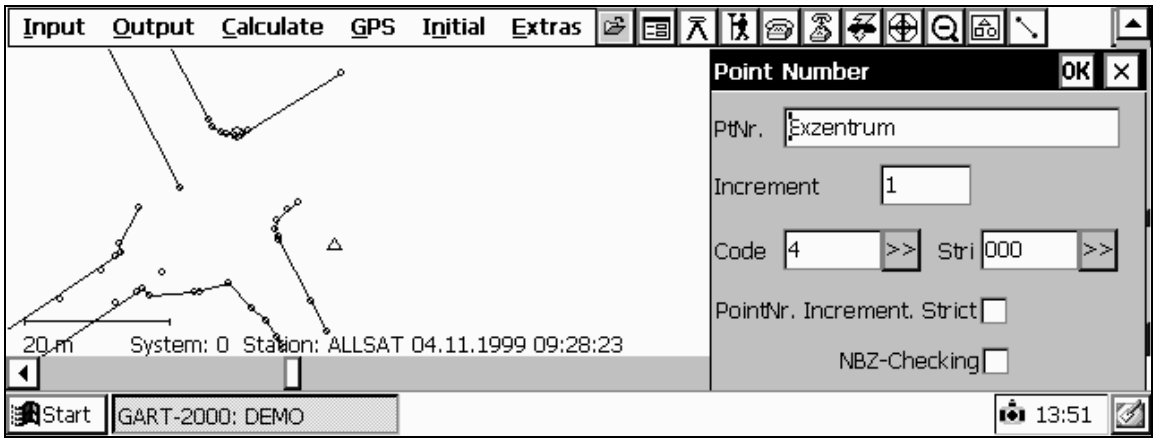


Figure 4-180: Constants Point Numbers

4.5.3.4 Coordinate Constants

The values in the ***Initial > Constants > Coordinates*** define within which tolerances ***GART-2000® CE*** saves coordinates under the same point number without notice.

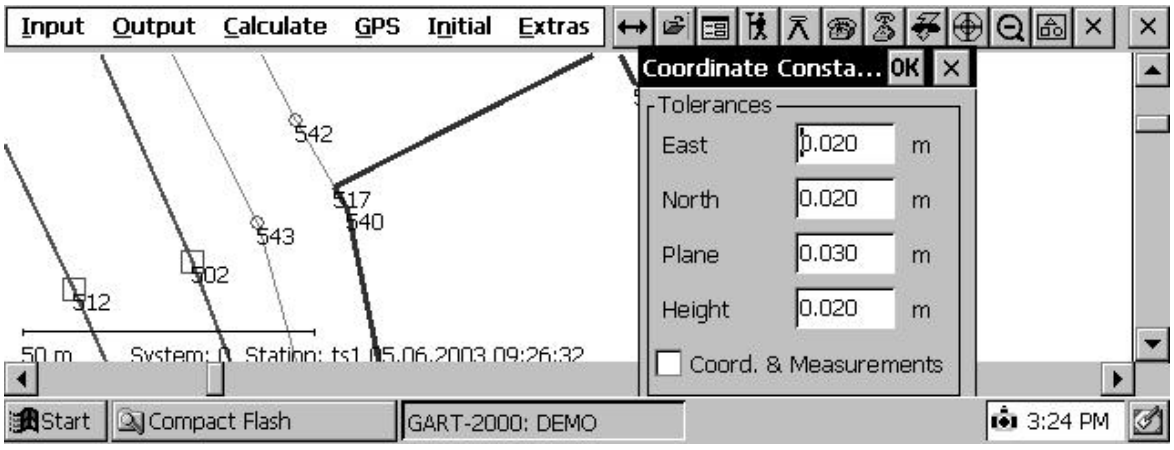


Figure 4-181: Coordinate Constants

In the fields **East**, **North** and **Height** the tolerances for the east, north and height coordinates can be entered. The default setting is 2 cm. Alternatively to the east and north tolerances the **Plane** distance can be used. ***GART-2000® CE*** will apply the lowest value. If the checkbox **Coord. & Measurement** is activated, the given tolerances are used for the storage of measured data, that means that ***GART-2000® CE*** saves only measured data, whose standard deviation is within the defined tolerances.

If a new coordinate with the same point number as an existing coordinate exceeds the tolerances, ***GART-2000® CE*** displays the ***Double Coordinates*** dialog showing the coordinate differences. The new coordinate can be saved or ignored.

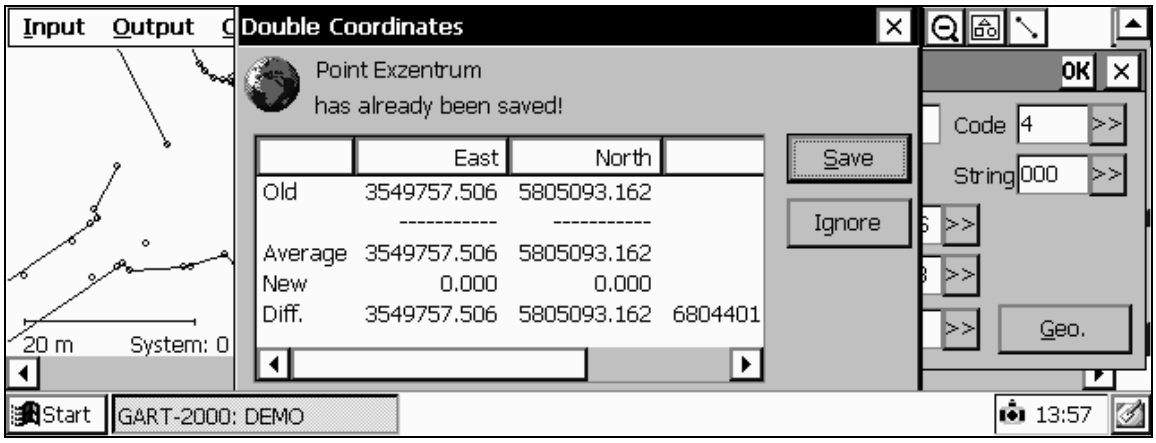


Figure 4-182: Double Coordinates

If the point code or the marker type of a new point differs to those of an existing point with the same point number, ***GART-2000® CE*** displays the ***New Code or Marker Type*** dialog.

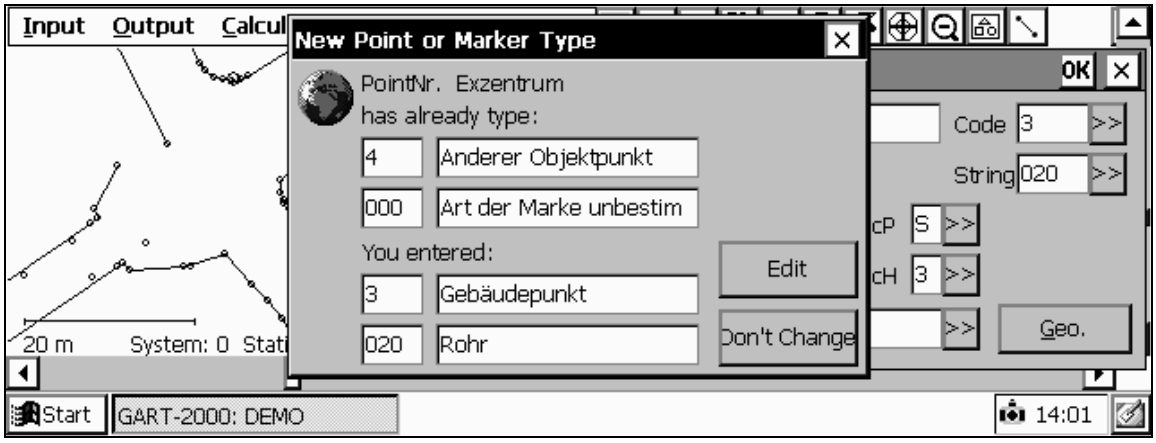


Figure 4-183: New Point or Marker Type

This dialog shows the code and marker type of the existing point in the first two rows and the code and marker type of the new point in the last two rows.

With the **<Change>** button the new code and marker type will overwrite the old values, whereas the **<Don't Change>** button keeps the old values.

4.5.3.5 Measurements

With the menu ***Initial > Constants > Measurements*** the tolerances for a multiple measurement and for a tripel-measurement can be defined.

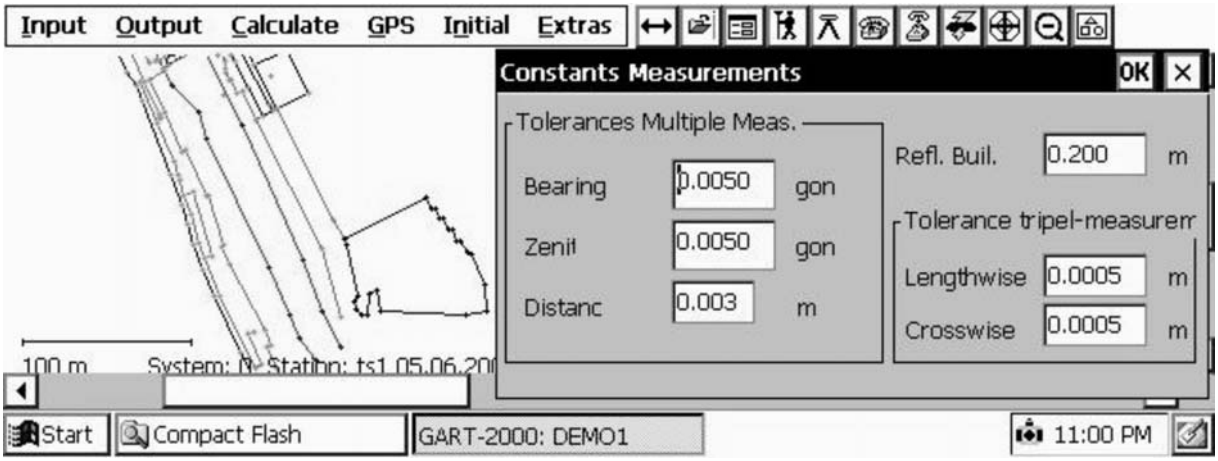


Figure 4-184: Dialog Constants Measurements

The tolerance for bearing and zenith can be entered in the field **bearing and zenith,** the tolerance for the distance in the field **distance.** The default settings for bearing and zenith are 0,0050 gon, for the distance 0,003m.

In the field **<Lenghtwise>** a tolerance for the lengthwise between two reflectors can be entered.

With **<Crosswise>** it is possible to enter the maximum allowable deviation of the middle reflector to the straight line built by the upper and lower reflector. The default settings are 0,0005m.

Additionally a value for a reflector building can be entered, it is initialised with 0,2m.

4.5.3.6 Radio

The menu ***Initial > Constants > Radio*** is only applicable for Sokkia- and NavCom-Receiver. Settings can be defined, so that corrections between base and rover can be sent via radio.

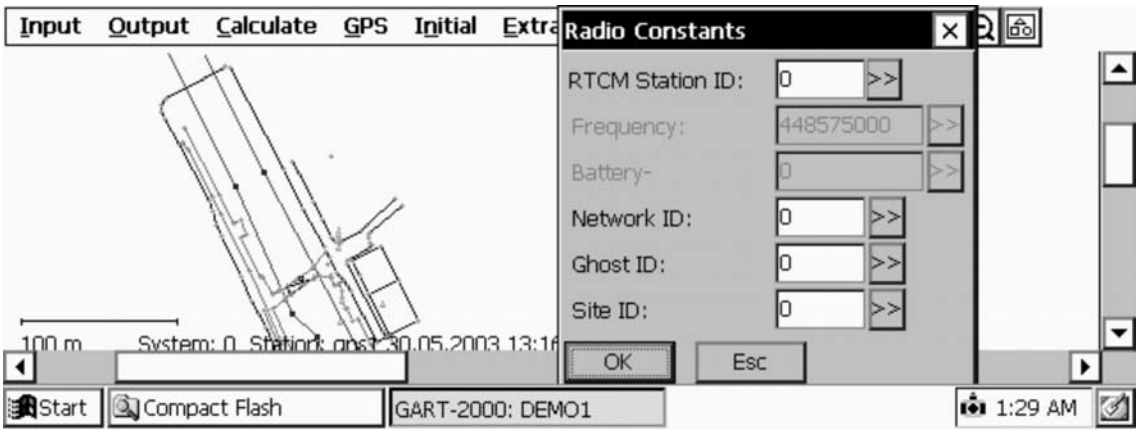


Figure 4-185: Dialog Radio Constants

4.5.3.7 Triple Rod

The geometry of a triple rod must be known for the calculation of the coordinates of a point which was generated by the elements of a triple measurement.

GART-2000® CE administers 10 Triple poles, which can be stored individually.

Calibration parameters can be entered in the main menu ***Initial > constants > Triple Rod***.

After selecting a triple rod and after confirming the choice by pressing the <OK> button, the user reaches the next menu.

The following options have to be entered:

- The **name** can be chosen freely

- Regarding the **type** the user has the choice between

- single prism,

- double prism and

- triple prism.

- Entering a value for the prism **constant** means entering a value to be added to the sloping distance. This value depends on the design of the prism.

- Entering a value for the prism **offset** means entering a value to be added perpendicular to the rod. Additionally, this value depends on the design of the prism.

- Entering a value for the **segment** means entering the debit measure of rod segments between two neighbouring prisms or between the lower prism and the top of the rod. The value of "segment below" is indicated as the target height during the measurement to a prism rod. This value can be changed if necessary (e.g. if the target height is measured using a measuring instrument or using an extension).

- Entering a value for the **addition constant** means entering the addition to the target height, if the target height is measured using a measuring instrument whose zero point (origin) is not identical with the lower prism.

4.5.4 System

The coordinate system is selected via the menu item ***Initial > System***. A pull-down menu appears, from which an existing system can be selected or a new system can be established by entering a new number.

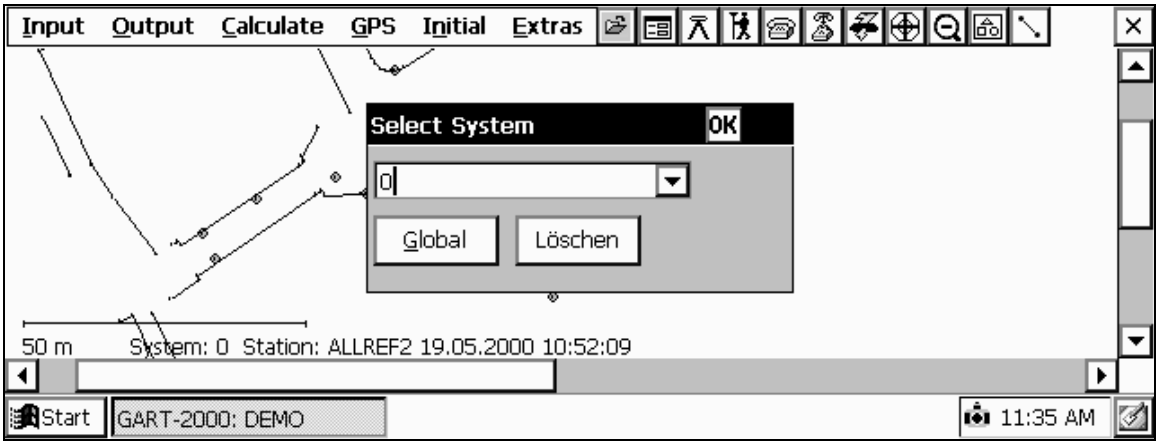


Figure 4-186: Select System

By clicking the button **<Global>**, a globally defined system can be selected. The definition of the system is then adopted in the project. A system can be globally defined by adopting the information in Edit System dialog by means of the **<Save>** button.

After selecting or entering the system, the specifications of the system appear. If a system is new and globally defined, the global settings are preset. A defined global system in the file **vpdefaul.cnf** cannot be altered in the Edit System dialog.

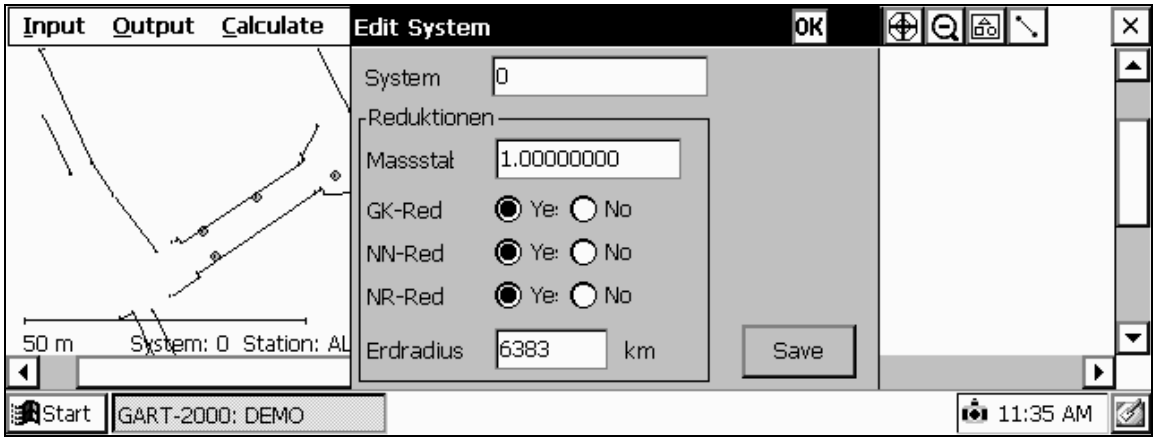


Figure 4-187: Edit System-Dialog to change system qualities

In this dialog settings are made for the reductions. These reductions are applied in the processing of measured values and in the conversion of distances and areas from coordinates into ground height. The following settings are possible:

Scale	Scale of the coordinate system. In a UTM system the scale factor must be given as 0.9996.
GK-Red	Switch for the Gauss-Krueger Reduction. The information required for the reduction is taken from the point database. The coordinates must therefore be entered with all the digits before the decimal.
NN-Red	Switch for the height reduction.
NR-Red	Switch for the slope reduction during the reduction of slope distance into horizontal distance.
Earth radius	Earth radius for the reductions in [km].

By clicking the button **<Save>** the system settings can be saved globally. If the system is only to be used within the current project, use the **<OK>** button. This button should also be used when you switch between individual coordinate systems.

4.5.5 Instrument

The total station to be used is selected under the menu item ***Initial > Instrument***.

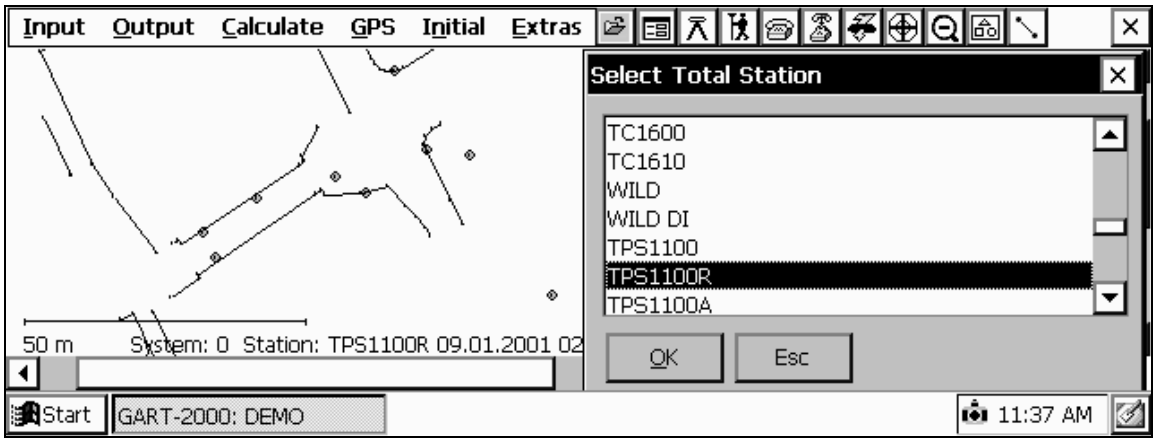


Figure 4-188: Select Total Station

After the instrument has been selected, the various instrument parameters can be entered or modified.

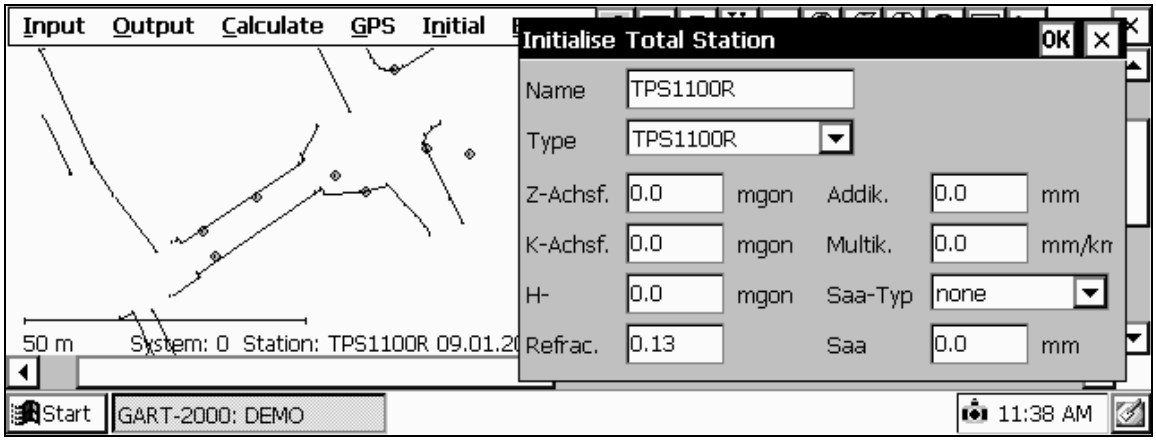


Figure 4-189: Input of instrument parameters

The different input fields denote the following:

Name	Designation of the total station.
Type	Total station type The specified type informs the program how the measured values are registered, i.e the type determines the interface parameters, the translation protocol and the data format. With the type ***Manual*** the measured values can be entered by hand.
Z-axisE.	Horizontal collimation error of the total station [mgon]
K-AxisE.	Trunnion axis error of the total station [mgon]
H-	Vertical index error of the total station [mgon]
Refrac.	Refraction coefficient
Add.	Zero-point correction (additive constant) of the total station [mm]
Multi.	Scale correction of the total station [mm/km]
Saa-Type	Transmit axis gap type Determines how the measurement occurs in the case of theodolites with attachable distance measuring devices. Three types are distinguished:

Case 1: ***Z/S parallel***: the distance measuring device is attached onto the theodolite telescope. The transmit axis is parallel to the sighting axis.

Case 2: ***SAA in vertical axis***: the distance measuring device is attached onto the theodolite telescope supports. The distance measurement takes place in the same way as collimation to the center of the reflector. The transmit axis gap always lies in the vertical (standing) axis.

Case 3: ***Z/S to reflector***: the distance measuring device is attached onto the theodolite telescope. Collimation and distance measurement is performed to the center of the reflector.

Saa Transmit axis gap [mm]

Accept the settings with **<OK>** or reject them with **<X>**.

4.5.6 Port Settings

In the ***Initial > Port Settings*** menu the settings for the RS232 device of the Handheld PC Pro can be done. COM Total Station, COM GPS or USB can be chosen.

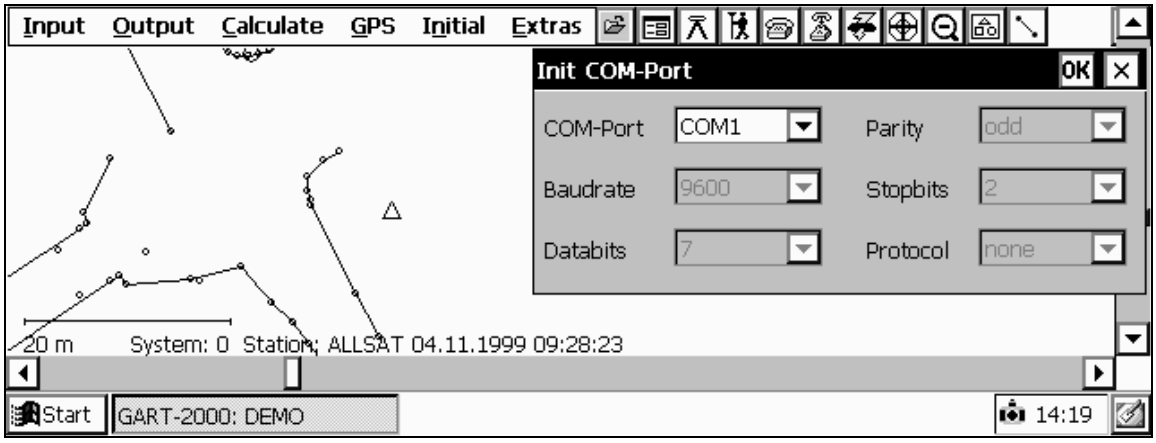


Figure 4-190: Init COM-Port

Normally it is sufficient to set the COM-Port (e.g. COM1 or COM2), because ***GART-2000® CE*** uses fixed internal parameters for the different GPS receiver-types and total stations.

4.5.7 Sheet definition (supported only in *GART-2000® NT / Viewer*)

With the menu **Initial > Sheet definition** a sheet can be defined and saved with an individual name.

First you have to zoom into the specific region, open then the sheet-definition-dialog with ***Initial > Sheet definition***.

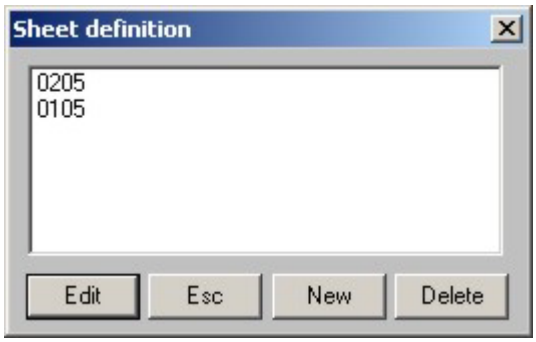


Figure 4-191: Sheet Definition

By pressing the button **<New>** a name for the selected region can be entered. Several modifications can be inserted additionally, like scale, coordinates of the lower left corner, width and height of the display window, width and height of the sheet, size and offset of the grid.

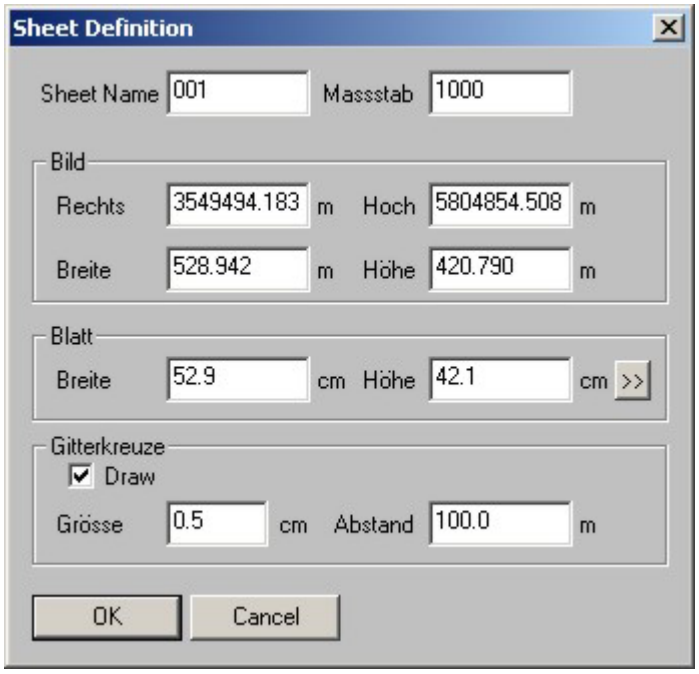


Figure 4-192: Input Sheet Definition

To modify settings of an already stored sheet, press the button **<Edit>**; to delete this sheet, press **<Delete>**.

4.5.8 Protocol

In the ***Initial > Protocol*** menu the protocol functions of ***GART-2000® CE*** (e.g. for calculation protocols) can be activated.

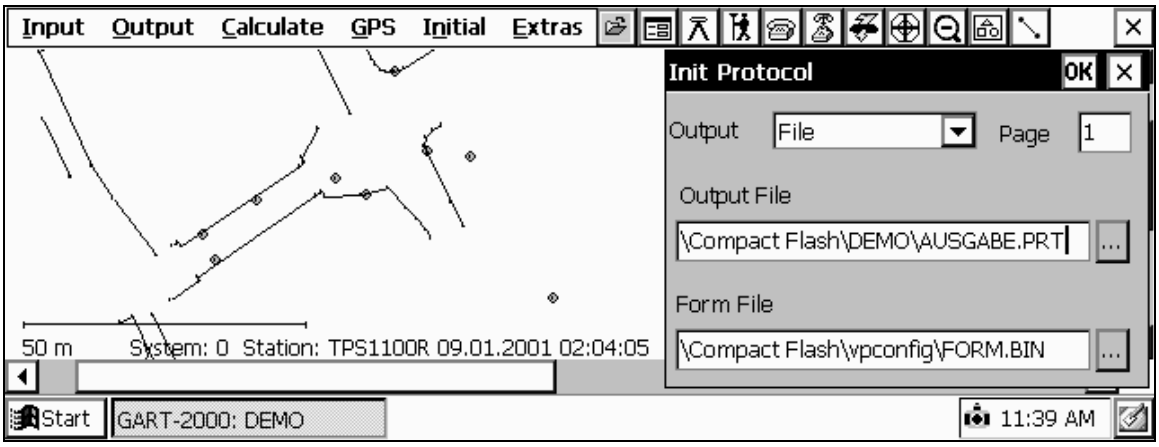


Figure 4-193: Initialisation of protocol functions

The selection "***File"*** in the field **Output** activates the protocol functions of ***GART-2000® CE*** whereas "***No Output"*** deactivates them.

The default extension for the **Output File** is **<PROJECTNAME>.prt** and the file location should be the project directory.

ATTENTION:	Never overwrite database files (extension *._DB). Otherwise these important files will be deleted and the project will be destroyed.

The protocol output files of ***GART-2000® CE*** contain a page number. This page number is incremented with any additional printed page. With the entry in the **Page** field the actual page number can be changed. In this manner, you can overwrite the current protocol file by restarting the pagination with '1'.

For the protocol output ***GART-2000® CE*** needs a **Form File**, which allows the free layout definition of measurement-, coordinate- and station protocols as well as calculation protocols. For this purpose a form translator is integrated into the free ***GART-2000® Viewer*** that supports the translation of individual form files. (see **4.6.2 Form**). During the installation procedure of ***GART-2000® CE*** a standard ASCII form file **FORM.FMT** and a translated binary file **FORM.BIN** is installed in the **vpconfig** directory.

Translation of new or changed form file works with ***GART-2000® Viewer*** in menu *Extras > Form.*

4.5.9 Display

The settings for the graphical output screen can be done in the ***Initial > Display*** menu. Alternatively, use the button shown above to choose this menu.

With the checkboxes on the first page the display of point symbols, point numbers, lines and notes can be controlled. By selecting the **<Map>** checkbox, a georeferenced map in bitmap format is displayed. All positions are made visible by activating the checkbox **<Position/Standpunkte>**. Default settings are point symbols and lines.

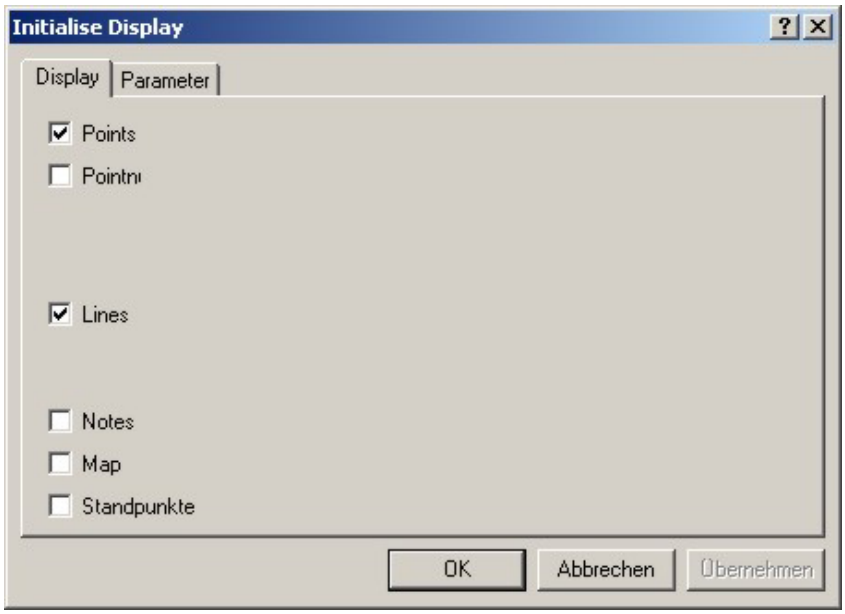


Figure 4-194: Init Display

On the second page **<Parameter> (only in *Gart-2000® NT* and *Gart-2000® Viewer)*** different definition-files can be selected and a scale can be defined.

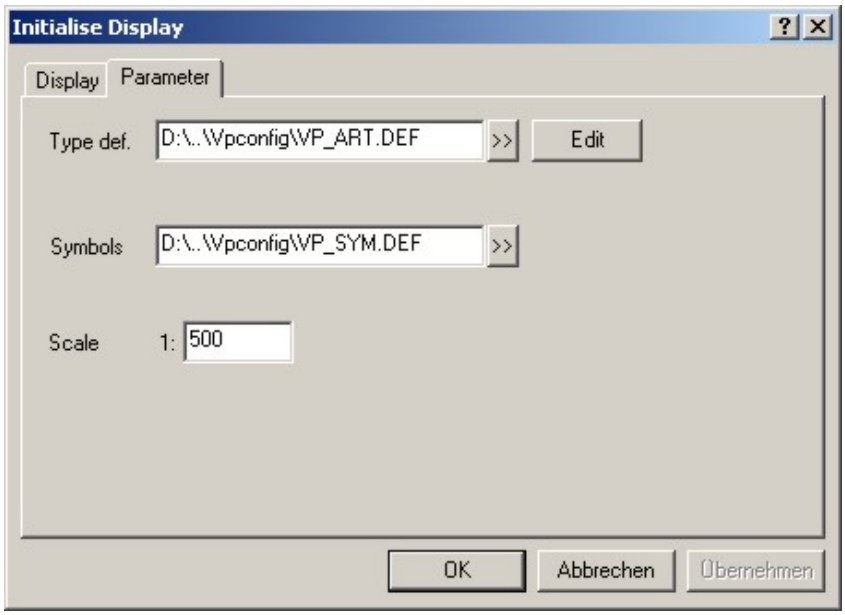


Figure 4-195: Selection of definition-files for the graphical display

By activating the button **Edit** a new dialog is opened, in which settings for the graphical display of points and lines can be made.

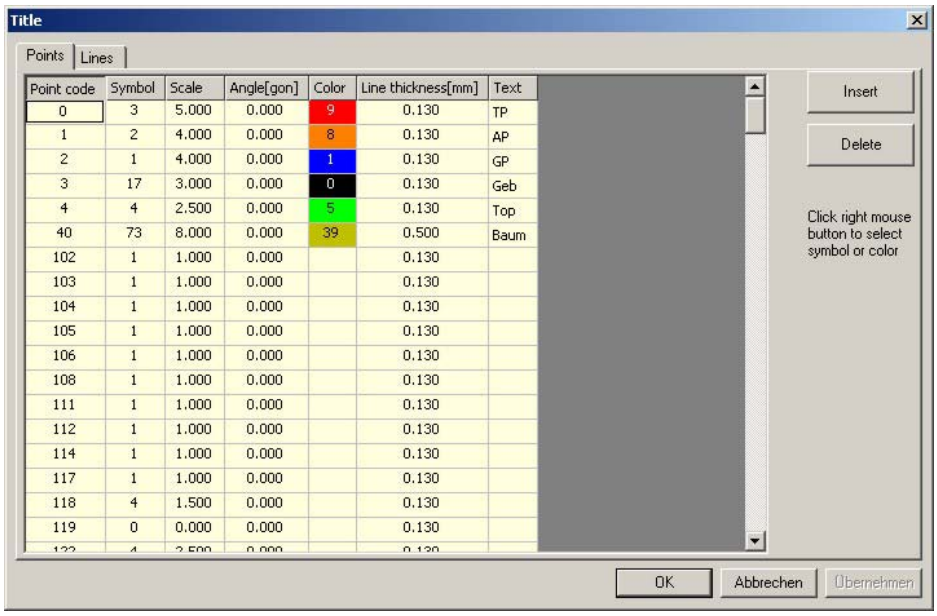


Figure 4-196: Dialog for the settings of the graphical display

Press on a symbol- or color-field with the right mouse button, a color table and a symbol list respectively is coming up. New colors and symbols for a special point code can be defined.

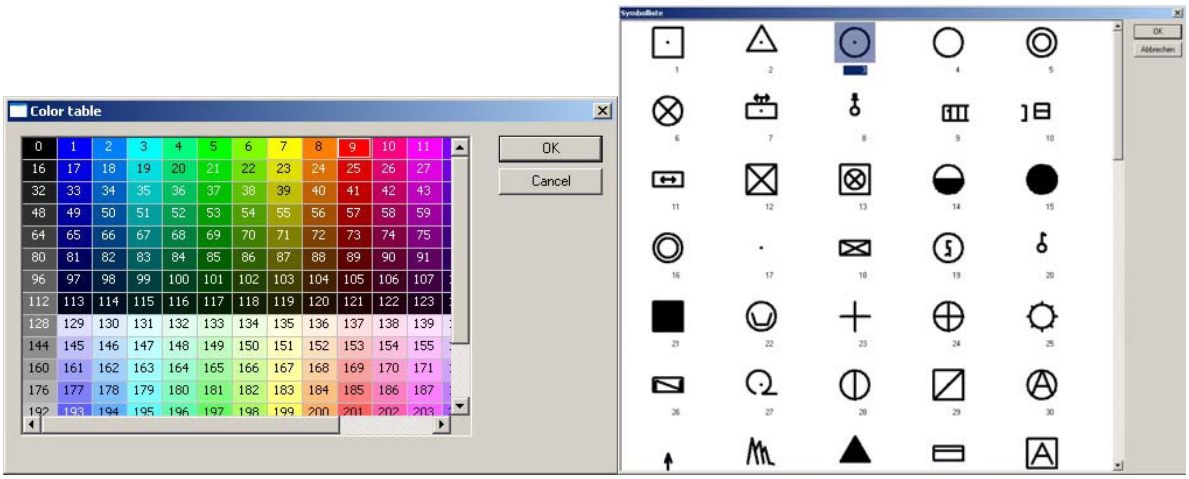


Figure 4-197: Display of the color table and the symbol list

4.5.10 Bitmap (supported only in *GART-2000® NT / Viewer*)

The menu item **Initial > Bitmap** is only implemented in ***GART-2000® NT*** and ***GART-2000® Viewer***. This facility allows projects with georeferenced bitmap files to be created there, which can be subsequently opened in ***GART-2000® CE***.

In order to georeference a bitmap, coordinates for the control points (e.g. corner points of the bitmap map) need to be entered first under **Input > Coordinates**. These can also be entered as geographical coordinates via the **<Geo.>** button.

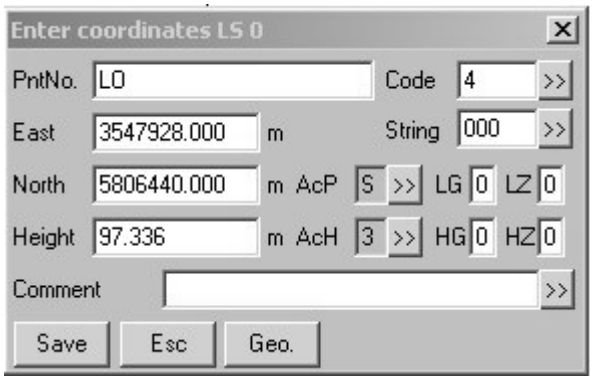


Figure 4-198: Input Coordinate

The Bitmap dialogue can now be called up via **Initial > Bitmap**. The bitmap file is opened by clicking the **<New>** button.

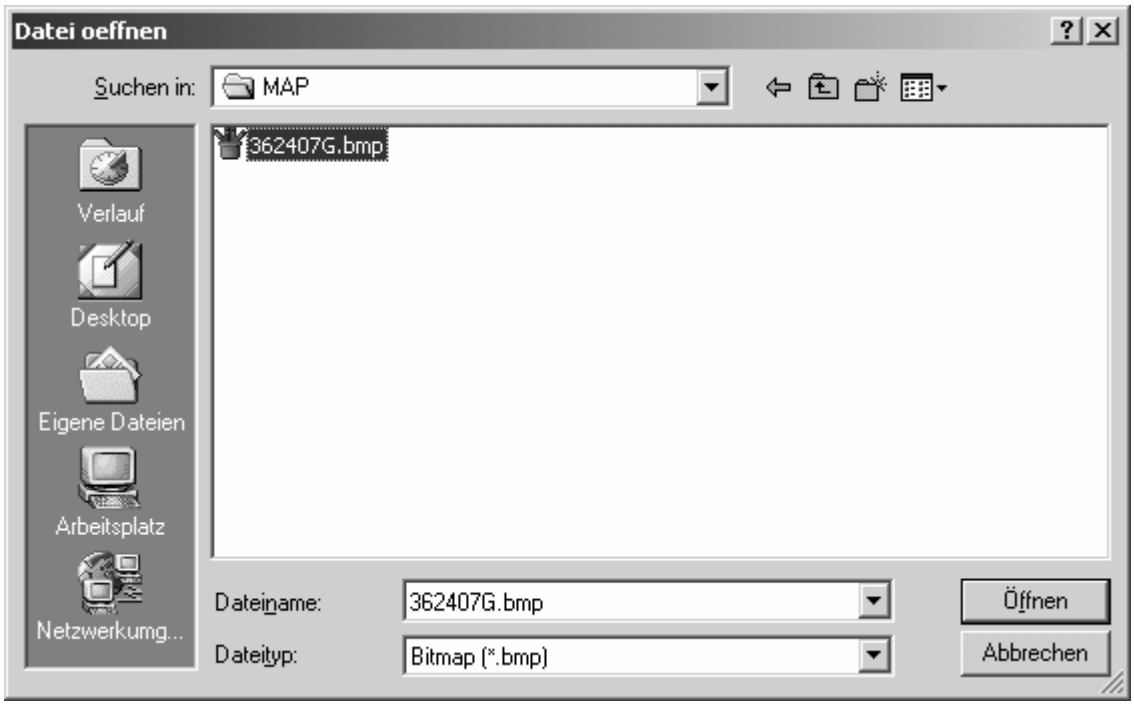


Figure 4-199: Open Bitmap file

After being confirmed with **<Open>,** the raster map is imported into the project and an initialization dialogue opens up.

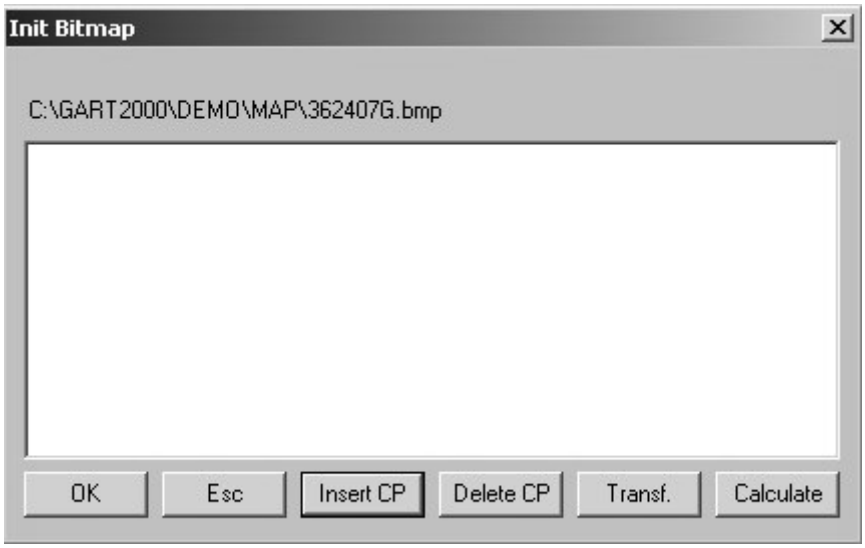


Figure 4-200: Init Bitmap

When the **<PP Input>** button is pressed, a window opens up for the digitization of the control points.

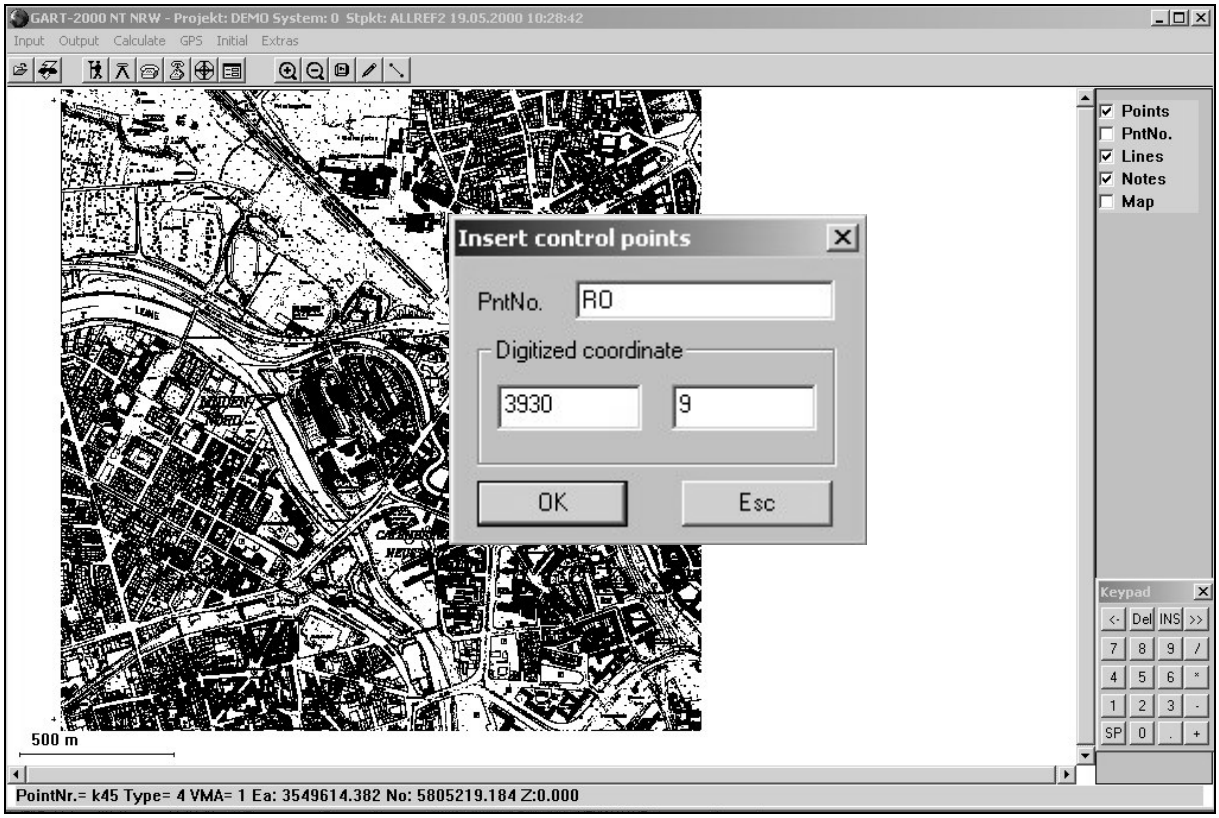


Figure 4-201: Digitize

To this end, the control point must be selected first (here: BR = Below Right) followed by the corresponding point in the image. The residual errors are already displayed during the input of the control points. Ideally, the four corner points should be chosen as control points to enable a precise accommodation of the map.

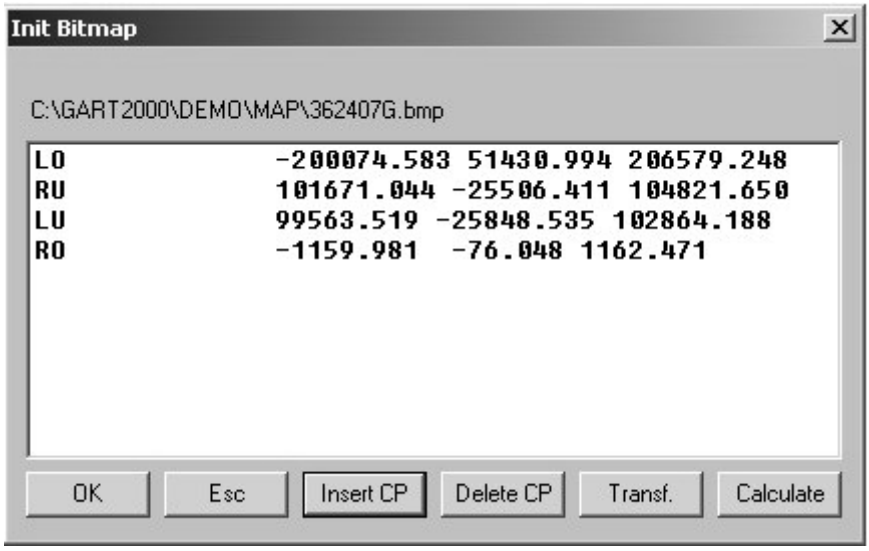


Figure 4-202: Overview control points

If the residual errors are acceptable, the transformation can be calculated by pressing the **<Adapt>** button. Selected control points (also called pass points) can be deleted with the **<Delete PP>** button. By means of the **<Tranf.>** button, the type of transformation can be specified for the map adjustment. If all the entries are correct, the dialogue can be closed with **<OK>**. For verification purposes, a further query is made at this stage that needs to be confirmed with **<Yes>**.

Figure 4-203: Safety check on new Bitmap

GART-2000® saves the bitmap files within the project directory in the folder **MAP**. The file vpmap.def contains the constants of the bitmaps loaded into the project:

0,1,3547928.096,5804440.233,3549928.116,5806440.218,"362407G.BMP"

System number,
Bitmap number,
Easting of the lower left corner [m],
Northing of the lower left corner [m],
Easting of the upper right corner [m],
Northing of the upper right corner [m],
File name

4.6 Extras

The menu ***Extras*** offers a variety of tools that make the work with ***GART-2000® CE*** and the operating system of your Handheld/Pocket PC easier.

4.6.1 Renumber

If a point is saved through the GPS-Measurements menu in ***GART-2000® CE***, both a measurement and a coordinate are saved under the same point number. The output of the coordinates is in alphabetical order whereas the measurement output is chronologically.

4.6.1.1 Single Point

The ***Extras > Renumber > Single Point*** menu makes the renumbering of both coordinates and measurements easier.

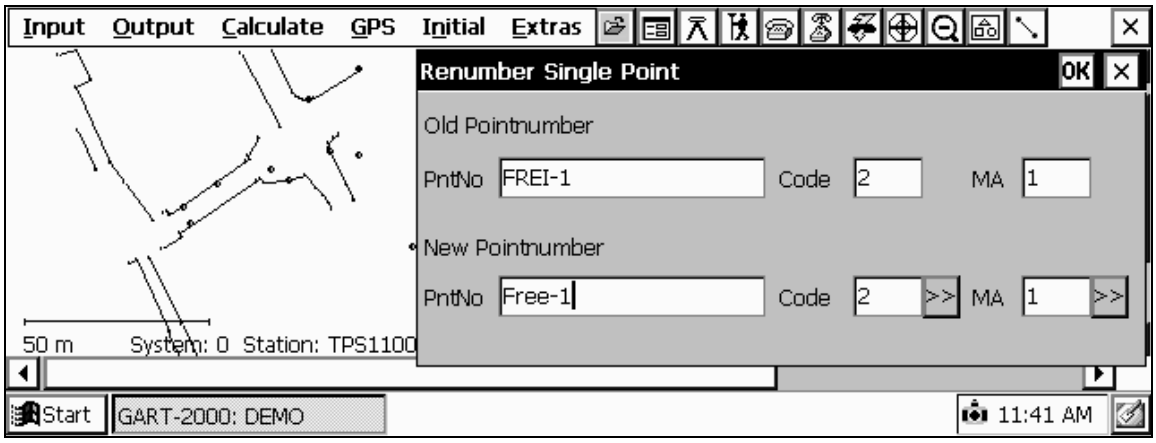


Figure 4-204: Renumber Single Point

In the ***Renumber Single Point*** dialog enter the old point number. The code and marker type will be added automatically. Then enter the new point number and if necessary the new code or marker type.

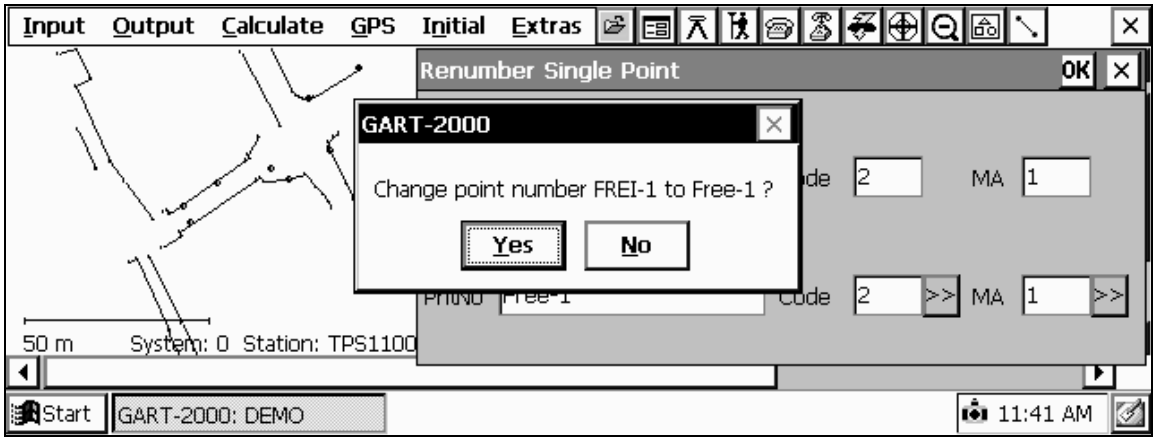


Figure 4-205: Confirmation to Renumber Single Point

To renumber the point press the **<OK>** button and answer the confirmation with **<Yes>**.

4.6.1.2 Block

To change the name, point code and marker type of several points, use the menu ***Extras > Renumber > Block.***

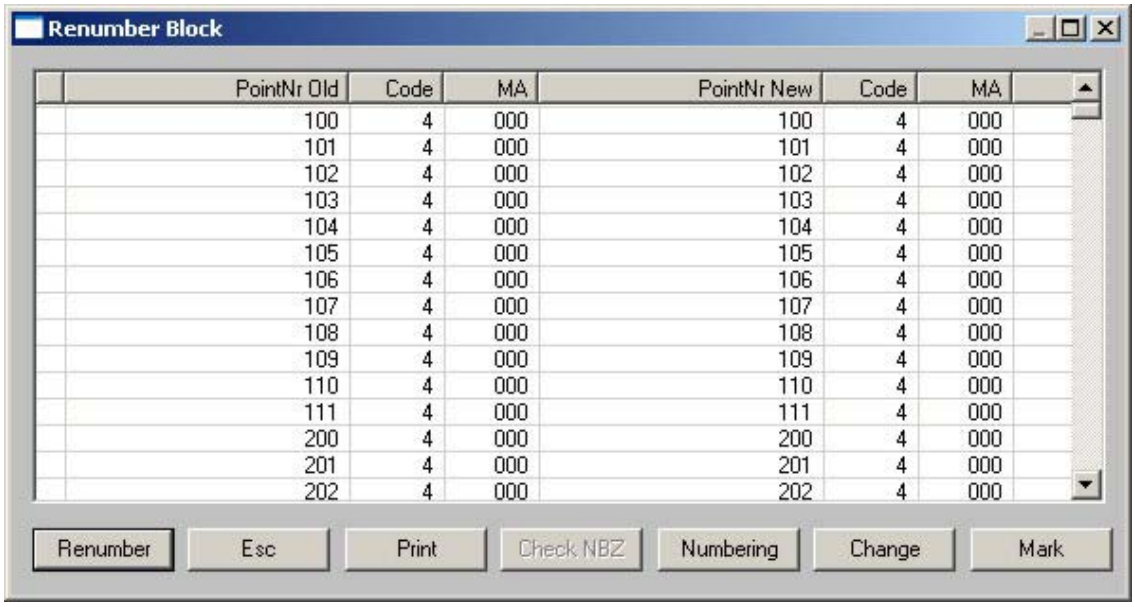


Figure 4-206: Dialog Renumber Block

By pressing the Button **<Change>** a selected point can be renumbered. Its point number and if necessary point code and marker code. To confirm any changes, press **<OK>**. The relevant point is marked with an 'X'.

To execute the renumbering of all marked points, press the button **<Renumber>** and confirm it with 'Ja'.

With the button **<Mark>** it is possible to mark several points at the same time. Alternatively you can mark them by clicking the left mousebutton and with pressed Shift- or Ctrl-Key.

The NBZ of all marked points can be compared with the NBZ calculated by the coordinates by pressing the button **<Check NBZ>**. And if necessary they can be changed. Modified points are then marked with an 'X'. To confirm any changes, press the button **<Renumber>**.

By pressing the button **<Numbering>** a group of marked points can be numbered after entering an initial value and an increment. Altered points are marked with an 'X' in the first column. To confirm any changes, press the button **<Renumber>**.

With **<Esc>** all changes will be discarded and the dialog will be exited.

Press the button **<Print>** to output the coordinates into a log file.

4.6.2 Form

GART-2000® allows the free layout definition of measurement-, coordinate- and station protocols as well as calculation protocols. For this purpose a form translator is integrated into ***GART-2000® Viewer*** that allows the translation of individual form files. The form translator is started with the menu ***Extras > Form***.

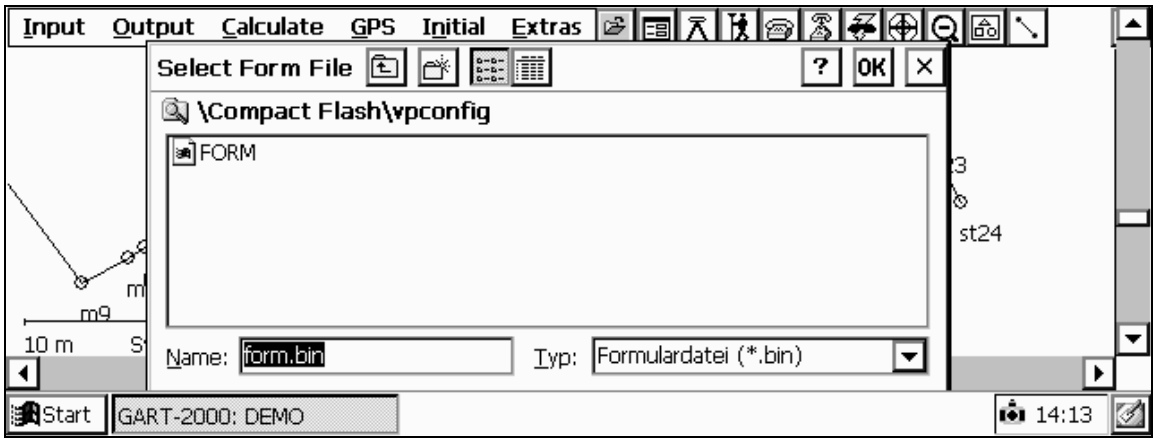


Figure 4-207: Open Form file

During the installation procedure of ***GART-2000® CE*** a standard ASCII form file **FORM.FMT** and a translated binary file **FORM.BIN** are installed in the *vpconfig* directory.

The translation process in ***GART-2000® Viewer*** creates a binary file out of the ASCII form file with the same name and the extension ***.BIN**. Normally the form translator of ***GART-2000® Viewer*** is not needed frequently, because the form files don't need to be changed so often.

At first glance the structure of the form file seems to be a bit complicated, but, actually, it is not that difficult. At the top of the file there is a list of basic definitions and parameters. The ***PAGELEN*** (pagelength) parameter defines how many lines are to be printed on one page. ***GART-2000® CE*** is doing the page switching automatically. ***"PAGEWIDTH"*** stands for the maximum number of signs per line. In the following lines global parameters are shown which define the names of the several transformation types in the form printout.

```
PARAMETER
PAGELEN=60
PAGEWIDTH=80
T_OS="Local System"
T_3P="3-Parameter-Transformation"
T_4P="4-Parameter-Transformation"
T_5P="5-Parameter-Transformation"
T_6P="6-Parameter-Transformation"
T_7P="7-Parameter-Transformation"
T_AB="North Orientation"
T_3PRF="3-Parameter-Transformation with residual estimation"
T_4PRF="4-Parameter-Transformation with residual estimation"
T_5PRF="5-Parameter-Transformation with residual estimation"
T_6PRF="6-Parameter-Transformation with residual estimation"
T_7PRF="7-Parameter-Transformation with residual estimation"
T_EP ="Single point adjustment"
T_MES =""
END
```

*Figure 4-208: Example of the form file **FORM.FMT***

Next, the individual forms are defined. Every form definition starts with the keyword ***"FORMULAR"*** and is followed by the form name.

In the next line stands the keyword "WITH", which indicates that a list of variables starts in the following line; these variables are needed for the respective form. To know which

variables are defined for the different forms and list types read up the form file FORM.FMT. The code word “DO” stands for the end of the variable list.

```
FORMULAR Koordinaten
WITH
 DATUM SEITE ZEIT
 SYSTEM
 PKTNR PKTART VERART RECHTS HOCH LG_LZ HOEHE HG_HZ
DO
@
@ Date: $$$$$$$$$$                    Page:##
@ Time: $$$$$
@
  Coordinate list
  ---------------
~ System: ###
~
~ PntNo   Marker Code   E [m]     N [m]    AP
~              Height [m]        AH
~ ============================================================
¦ $$$$$$$$$$ #####  ##### ############ ############ ##
¦              ########        ##
¿
END
```

Figure 4-209: Example of the form file (form coordinate list)

The following lines define the layout of the corresponding protocol. The lines between ***“DO”*** and ***“END”*** are printed the way they can be seen in the form file. The first sign of every line is not printed, but serves for the control of printout functions:

	Lines, which start with a blank are, only printed at the beginning of a new form (here "**Coordinate list**" and the underlines).
@	The @ sign (ASCII 64) indicates that this line is printed at the top of every new page.
~	The title which stands above every table is defined by a ~ (ASCII 126). In our example the table title shows the coordinate system as well as the column titles such as point number, marker type, point code, east, north,… . The table title is also printed at the top of every new page.
¿	An upside down question mark (ASCII 168) shows that after the end of the form a new page follows.
¦	A "pipe" sign (ASCII 124) stands in front of lines that define the layout of a table entry. In our example the entries in the coordinate list are split up into two lines.

At the end of a form definition stands the keyword ***“END”***. In the form file ***FORM.FMT*** further form definitions for other lists and forms follow.

Within a form two special signs determine the layout and location of the entries:

$	A dollar sign stands for an alphanumeric sign, e.g. a letter or a number. The maximum length of the string is determined by the number of the dollar signs. Strings are always left orientated. In our example, ten digits are reserved for the point number.

#	The number sign stands for integer or float numbers. The point defines the number of decimals. In our example, *GART-2000® CE* would reserve two digits for the page number, whereas for the coordinates twelve digits and three decimals are reserved.

The parameters between ***"WITH"*** and ***"DO"*** are written in the respective order into the fields.

If the form file was changed it needs to be translated with the menu ***Extras > Form***.

4.6.3 Version

The menu ***Extras > Version*** shows the program version number of ***GART-2000® CE***. Furthermore, the owner of the ***GART-2000® CE*** software license is displayed.

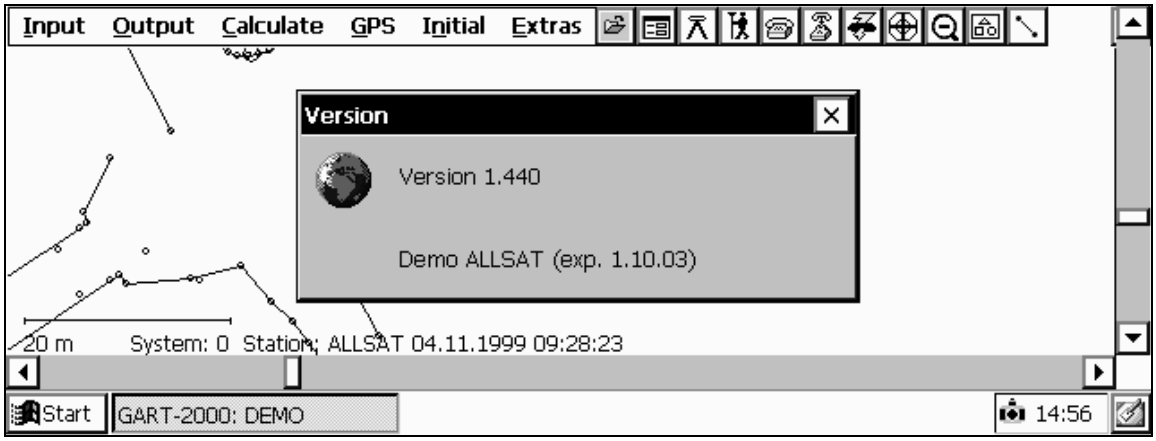


*Figure 4-210: Version of **GART-2000® CE***

4.6.4 Zoom All

With the menu ***Extras > Zoom All*** it is possible to zoom back the graphic screen in one step to the full project overview.

4.6.5 Zoom Sheet (only supported in *GART-2000® NT / Viewer*)

To zoom on a predefined sheet (predefinition with ***Initial > sheet definition***), select the menu ***Extras > Zoom Sheet.***

4.6.6 Pan (only supported in *GART-2000® NT / Viewer*)

To move the map manually, click on the graphical screen with the right mouse button and perform a movement into the desired direction.

4.6.7 Zoom –

To zoom into the graphic, mark the corresponding rectangular region with the pen. For zooming out of the graphic step by step use the button shown above or choose the menu ***Extras > Zoom*** –. Every additional execution of this function will zoom back the graphic until the full project overview is visible.

4.6.8 Keypad

The keypad serves as an alternative to the keyboard (e.g. for a Tablet PC) and only occupies a small area of the display. All digits, upper-case letters and several special characters can be entered in all the input fields with the aid of this keypad.

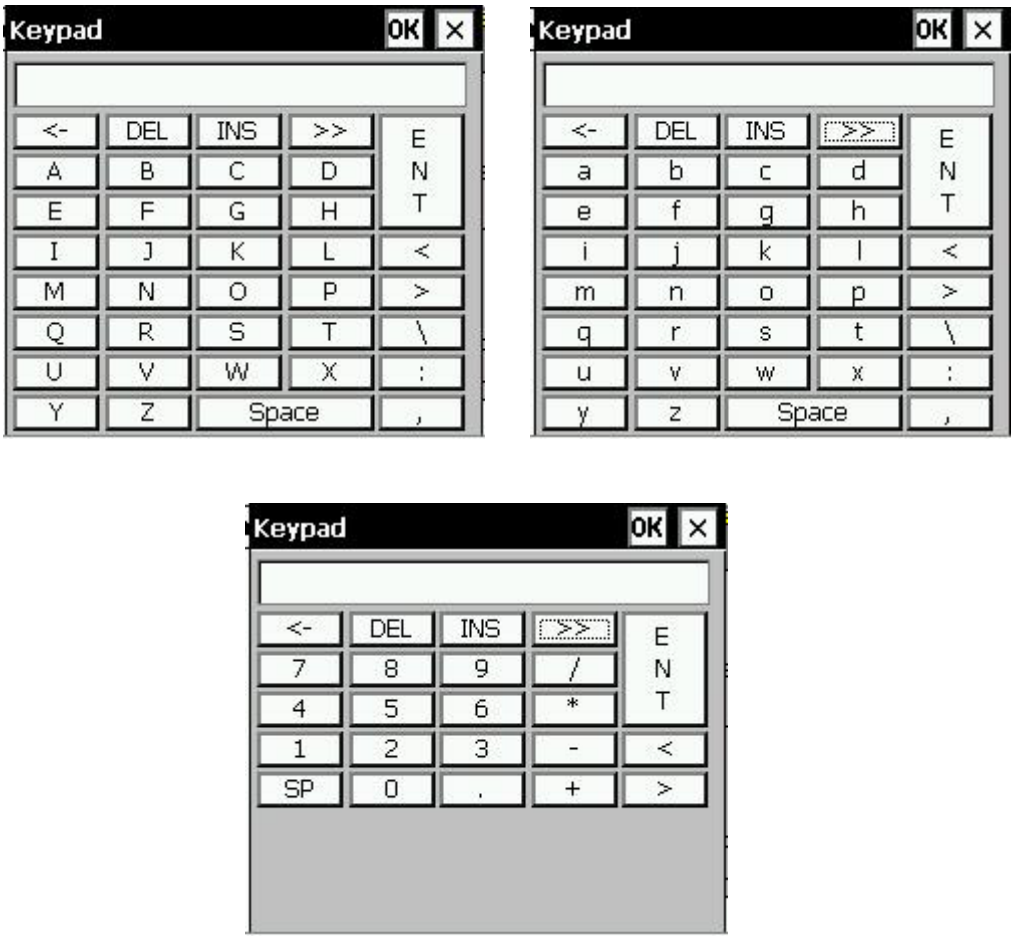


Figure 4-211: Keypad

With the button shown above or the menu ***Extras > Keypad*** an option can be activated, that the keypad is called up after clicking in an input field. An existing input is then transferred to the keypad and can be modified.

You can switch between the individual blocks of keys using the **>>** key. The **<-** key acts as the backspace key and deletes the last character entered. **<Del>** and **<INS>** correspond to the functions Delete and Insert on the standard keyboard. To overwrite a transferred input, press **<INS>** first and make a request afterwards. **<** or **>** acts as the right or left arrow key of the standard keyboard and changes the cursor-position. By pressing the **<ENT>**-key the keypad-input is deleted within the keypad, the keypad-input is then transferred to the input field of the relevant dialog and finally the keypad is deactivated. The keypad is closed with **<X>**.

4.6.9 Graphic Mode

When the graphic mode is activated, the current dialogues are placed in the background and the graphic is displayed in the foreground. The graphic mode facilitates rapid switching between dialogue windows and the graphic in devices without a display, as is the case, for instance, with a Pocket PC.

4.6.10 Text Editor

To start a text editor directly from ***GART-2000® CE*** (e.g. to edit a protocol file), choose ***Extras > Text Editor***. The *Open File* dialog is started and the selected file can be edited.

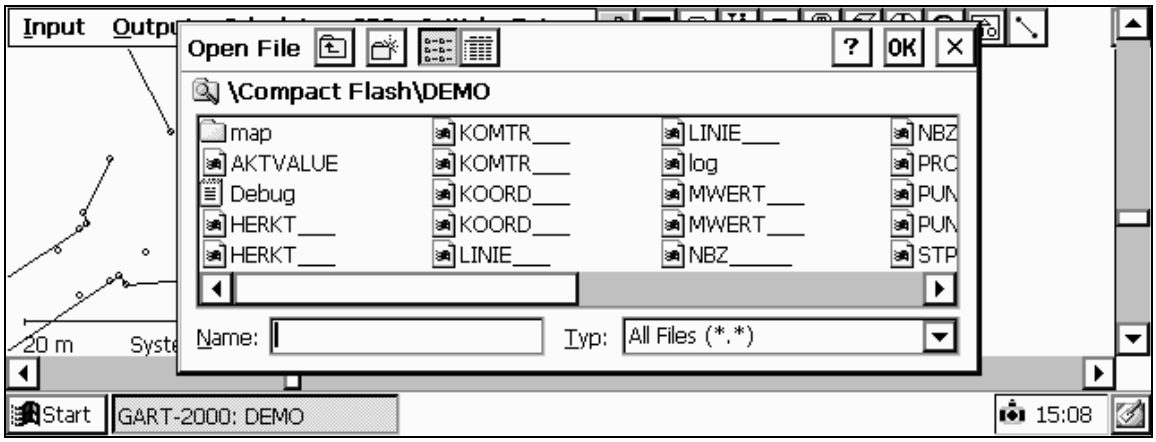


Figure 4-212: Opening a file with the editor

The actual text editor is defined in the **vermpro.cnf** file and can be changed if needed.

4.6.11 Help

If you need help while working with ***GART-2000® CE*** outside in the field, choose the ***Extras > Help*** menu. The Microsoft® Internet Explorer is started with the Online-Help of ***GART-2000® CE.***

4.6.12 Language

With ***Extras > Language*** an online change between various language versions of ***GART-2000® CE*** can be done:

- German
- English
- Norwegian
- Finnish
- Spanish
- French
- Italian
- Dutch
- Swedish
- Portuguese
- Polish
- Hungarian
- Serbian

On request, we will gladly implement other languages.

4.6.13 Database

4.6.13.1 Create new Index Files

With ***Extras > Database > Create new Index Files*** you are able to re-create destructed Index data of ***GART-2000® CE***-Database.

4.6.13.2 Backup

With ***Extras > Database > Backup*** of the actual project is generated and stored in the project directory.

4.6.14 License

Please enter your own User-Key in the field “User-Key” in order to use ***GART-2000®*** as a full version.

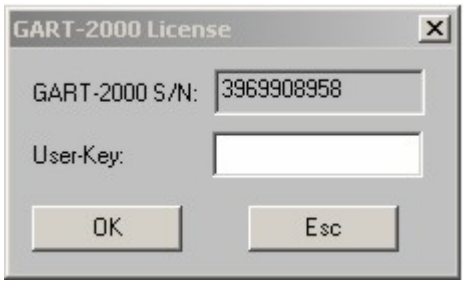


*Figure 4-213: **GARD-2000** License*

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